GRADED LESSONS

IN

HYGIENE

KROHN

AN X-RAY PHOTOGRAPH OF THE HAND (SHOWING TWO NEEDLES IMBEDDED IN THE FLESH)

PUPILS' EDITION

GRADED LESSONS

IN

HYGIENE

BY

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CHICAGO

WILLIAM O. KROHN AND COMPANY

1902

The Lakeside Press
R. R. DONNELLEY & SONS COMPANY
CHICAGO

PREFACE.

The keynote of this book is *health*. There has been no attempt to prepare an extended treatise on anatomy and physiology. It has been the purpose of the author to present in simple language to the children in the intermediate grades a knowledge of the conditions which tend to preserve and strengthen the body.

While the facts of anatomy and physiology in this book have been made in a sense secondary to the main theme—hygiene—yet they embrace the results of the latest investigations in these departments of research, and are ample for a clear understanding of the central subject. The lessons are designed throughout to come within the comprehension of young pupils, as well as to meet the wants of those in the more advanced classes, in emphasizing the common laws of health. This steady progression from the simple to the more difficult is made by easy, natural, well-gradated steps.

The author regards it not only the most logical arrangement, but also in harmony with the best pedagogy, to embrace the main discussion of the effects of alcohol and tobacco in separate chapters. Connected discussion is better than scattered fragments.

In the teacher's edition of this book, more specific directions are to be found for presenting the subject-matter of these lessons. This supplement for teachers also includes suggested exercises for use in gymnastic drill, as well as a series of tests for hearing, vision, memory, and the methods of making physical measurements. There is also contained in the teachers' edition a more extended discussion of the effects of narcotics and alcohol upon the human system, and the methods of teaching the same.

WILLIAM O. KROHN.

Chicago, May 1, 1900.

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"For what will it profit a child if he gain the whole world of knowledge and lose his own *health?*"

G. Stanley Hall.

CHAPTER I.

OUR FOOD.

Why We Eat.—Does it ever seem strange to you that these bodies of ours do not appear to wear out, though we are constantly using them? We know that our clothes wear out, no matter how careful of them we may be. A wagon or piece of machinery tends to wear out with each movement it makes. You would not expect your pencil, pocket-knife, bicycle, or skates to keep fresh and new after long and frequent use. Our bodies are constantly wearing out. Every movement of our bodies, however slight, causes at least a small amount of wear. Why, then, do not our bodies waste away? Because they are being continually repaired. Every little particle of worn-out matter is being replaced by a new one. The food we eat is being changed into the parts of the body that are wearing out.

You are growing very fast. But a few years ago you were much smaller than you now are. Next year you expect to be even larger and stronger. What is it that makes you grow? Is it the air that you breathe? No, not that alone. Air is necessary to life; but you would soon starve if you had nothing but air upon which to live. Water is necessary to life, and yet none of us could live on water alone. You have noticed the little tree in the orchard and the plant in the garden, how

rapidly they grow. If you should stand the plant or tree in the middle of your schoolroom, on the clean, hard floor, and give it sunlight, air, and water, without any soil, would it grow? No; it would not even live. The roots, by means of which our little tree, when out of doors, was fastened to the soil, could not make their way into the hard floor.

If the tree is to live and grow, its roots must go down into the soil and find something for the tree just as necessary to its life, health, and growth, as the air, sunshine, and water. The roots, even the smallest of them, work down into the earth and find food for the tree, and it is this food which the roots find that makes plants and trees grow. The richer the soil—that is, the better the food—the faster they grow. In one garden we find the plants looking pale and sickly, growing scarcely at all, while in another garden the plants look fresh and thrifty and are growing rapidly. What causes the difference? You are quick to answer that in one garden the soil is richer, containing more food for the plants, and the gardener loosens the soil that the roots may have a chance to push their way farther and farther into the earth to get more food. The wise gardener also pulls up the weeds that would otherwise grow around the plants, so that these weeds may not use up the food in the soil that the plants need for their health and growth.

Why do you eat? Because the food keeps your bodies in repair so that they will not wear out, and also because it makes you grow.

Have you ever thought how much one eats in a lifetime? It is a nice problem in arithmetic to figure this out. Nearly every boy and girl in your school eats at least two pounds of

food in a day. In a year, then, each of you will eat two times 365 or 730 pounds of food. This is many times your own weight. By the time you have become sixty years old, how much will you have eaten?

What to Eat.—Our bodies are repaired and made to grow by what we eat. If you eat inferior food your bodies will be made of poor material, and will not grow as fast as they should, or do their work well. If you eat poor, unhealthful food, your body will have to be repaired often; that is, you will have to call the doctor to give you some medicine to undo the harm caused by the improper food, whatever it may have been. You see how important it is that we know something about our foods. All of us should know what foods are good for us, and what will do us harm. What foods will promote health and growth, and what will cause disease and retard growth, is certainly very important knowledge.

Do you think the dark soil in the garden or flower-bed looks anything like the bright-eyed, laughing pansy? Does the black loam resemble the rich green of the waving branches of the fern? As we eat the ripe apple, juicy plum, luscious grape, or sweet pear, do we taste anything like the dark, gritty, sandy soil which made it possible for them to exist? To all of these questions you answer, No. And yet in the same way the roots of the pansy, the fern, and the fruit tree take their food from the soil, and it is then changed so that leaves are made to grow, flowers to bloom, and fruits to appear.

Is it not equally strange to think that the bread, potatoes, meat, and eggs you eat, as well as the milk and the water you drink—in fact, every bit of good food of which you partake—is

taken up by the organs of the body and changed into bone, nerve, and muscle? And yet, if we can only get the food into the blood, as the root gets the food from the earth into the sap of the plant, each part of the body will pick out just what it needs to make it strong. The bones will take up from the blood just those little particles they need for their growth and repair, and likewise, the muscles and nerves will do the same. Your own body does not look like the food you eat any more than the plant looks like the soil upon which it feeds. Our food becomes changed in some way into all the different parts of the body—skin, hair, bone, muscle, brain, and nerve.

Since food thus becomes changed into the different parts and organs of which the body is composed, is it not very important that we be careful to select the foods that are best suited to the repair and growth of our bodies? But before we consider this further, let us follow the food we eat as it makes its journey through the body. The preparation of the food so that it may be used in nourishing the body is *digestion.* The object of digestion is to separate the food from its hard and useless parts, and then to soften and dissolve it so that it becomes liquid, and can flow with the blood to the various parts of the body requiring food.

How We Digest.—The first step in digestion is the proper cooking of the food we eat. Our digestion, then, really begins outside of the body. Cooking softens the food so that it can be chewed easily. You would find it difficult to chew raw rice grains. Cooking softens the hard grains of rice, wheat, or oats, and it also makes most of the foods taste better. A raw potato does not taste very good, but what boy or girl does not enjoy

eating nicely cooked potatoes at least once a day? Again, cooking destroys many poisons in food. We will learn more about that in the chapter on "Disease Germs."

Mouth Digestion.—After the food is properly cooked, the next step in digestion is to take it into the mouth, where the digestion is continued by chewing and grinding the food with the teeth, and pushing it about the mouth with the tongue. We move it from one side of the mouth to the other until it is in little, fine particles. While we are chewing our food well, it is mixed with a watery fluid, called *saliva*. There are three glands on each side of the mouth that are busy making and secreting this saliva. You will see their location in the picture. The saliva which the glands produce is sent into the mouth by means of little tubes called *ducts*. When we eat, taste, or even look at some foods we like, these glands make so much saliva that we sometimes say the mouth waters. You should remember to eat slowly, in order to give

FIGURE 1.—The Salivary Glands.

your teeth a chance to grind up the food, and also give it time to become well mixed with the saliva of the mouth, which helps so much in preparing the food for the further steps of digestion. After being thoroughly chewed, the food is swallowed.

Stomach Digestion.—In the back part of the mouth, at the throat, begins a long, narrow tube, which passes down to the stomach. This tube, or food-pipe, is about nine inches long. It is called the *esophagus.* You all know where the pit of your stomach lies. This is the stomach's center. The stomach is simply an enlargement of the digestive tube. It is like a large bag with a coat of loosely woven muscles, and it has a queer little gate-keeper or valve (pylorus) at the lower end that will not open and permit the food to pass out until it is sufficiently digested and ready for the bowels or intestines. As soon as the food gets into the stomach, the muscular coat begins to contract, first lengthwise and then crosswise. It thus keeps the food churning to and fro, and mixes it with a fluid or juice more powerful than the saliva of the mouth. This fluid in the stomach, so necessary to digestion, is called the *gastric juice.* It is formed

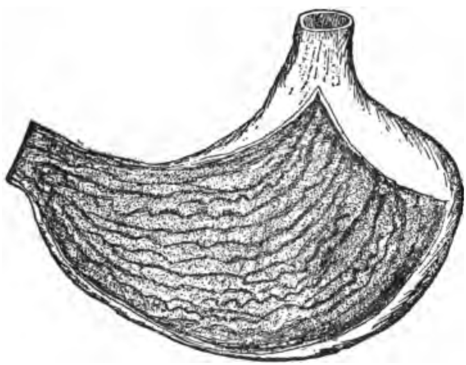


FIGURE 2.—The Stomach, with front walls removed to show inner lining.

in the many pocket-like glands in the lining of the inner wall of the stomach. The stomach churns away from two to four hours after every meal, according to the kind of food eaten, the way in which it has been cooked, and the health of the person eating it. After each meal the stomach should be allowed to rest a while before the next. This is why girls and boys should, as a rule, eat nothing between meals. If you do, the stomach becomes too tired to do its work well when meal time comes again, and so you are not hungry. Irregular habits of eating, as well as improper, unwholesome food, will cause disorders of the stomach, such as dyspepsia. Again, the gastric juice will not digest the foods in the proper length of time if the pieces are too large and not properly chewed or masticated when swallowed. This is another reason for eating slowly. It should also be remembered that the juices so necessary to digestion are secreted more rapidly and do their work better if we are in a cheerful mood. If we come to the table cross and peevish, the food we eat will not do us as much good and will not be so well digested as it would be if we were cheerful and happy. Cheer is necessary to good digestion.

The blood vessels of the stomach dissolve and take up some of the food and carry it away, but most of the pulpy mass, after being thoroughly mixed with the gastric juice, passes through the little gateway, or pylorus, to the intestines, to be mixed with still another juice.

Digestion in the Intestines.—At the lower end of the stomach the food canal becomes narrow again. This portion of the digestive canal below the stomach is called the *intestines* or bowels. The intestinal tube is about twenty-five feet long in

the grown person. This long portion of the food canal is coiled up and closely packed away in the cavity of the abdomen, below the stomach, so as to take the smallest possible amount of room. The last few feet of the intestinal tube is larger than the rest, and is called the *colon.* The portion directly attached to the stomach is longer, but at the same time much smaller, and is called the *small intestine.* It is about twenty feet long and one inch in diameter. The small intestine opens into the large intestine or colon, which is about two inches in diameter, and in the adult about five feet in length. The entire intestinal canal, then, consists of a tube of muscular tissue lined with a mucous membrane. The walls of the intestines are from one-sixteenth to one-eighth of an inch in thickness. On their inner surface, imbedded in the mucous membrane, are innumerable small tube-like glands that are very important. They pour out a liquid called the *intestinal juice,* which does its part in the digestion of food. Along the lower side of the stomach there is a large gland called the *pancreas* or *sweet-bread.* Each day this pours into the intestines about one quart of a liquid called the *pancreatic juice.* This juice is even more important than the saliva, gastric juice, or intestinal juice, for it does most of the work of digesting our food. It is so powerful that it breaks up the fats in our food, such as butter

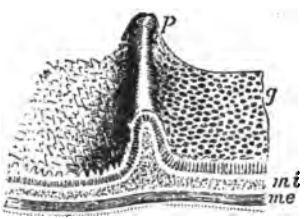


FIGURE 3.—Showing the Three Coats of the Stomach. (*g*) Inner surface, mucous membrane. (*mi*) Circular layer of muscular fibers. (*me*) Outer layer of longitudinal muscular fibers. (*p*) Ridge of pyloric ring.

and the fatty portions of meats, into very small particles so that they will mix with water. The pancreatic juice also changes the starch in our foods, as the starch of potatoes, bread, and uncooked fruits, into the sugar the body so much needs.

The *liver*, which is located above the stomach, close under the ribs and on the right side of the body, is a large chocolate-colored organ, and has for its chief business the making of a fluid called *bile*. This fluid is also very necessary for the digestion of the food in the intestines. Fresh human bile is a liquid of a brownish gold color. It is carried to the intestines through a little tube or duct, called the gall-duct. This enters the intestines just a few inches below the stomach. If the liver makes bile faster than it is needed by the intestines, it is stored up in a little pear-shaped sac, known as the gall-bladder. This hangs from the under side of the liver. The saying, "bitter as gall," arises from the extremely bitter taste of the bile in the gall-bladder. Sometimes in cleaning a chicken or other fowl in preparation for cooking, by drawing out the liver, intestines,

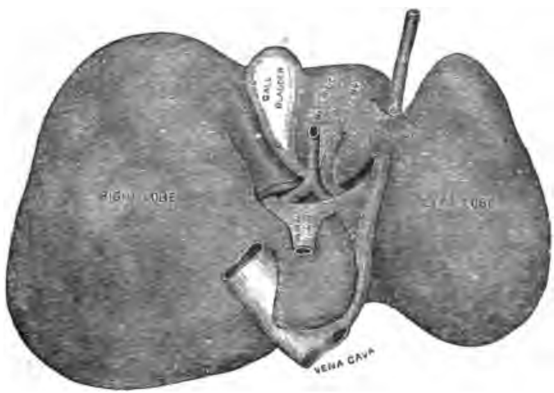


FIGURE 4.—THE LIVER—Its Under Surface.

heart, and other organs, the gall-bladder becomes broken, and the bile it contains comes in contact with the meaty portions of the fowl to be eaten. These are rendered, because of the intense bitterness, entirely unfit for food.

While the bile is very important, it of itself does very little of the work of digestion, but its presence makes the pancreatic juice more powerful. Mixed with bile, the pancreatic juice is able to do double the work of digestion that it could do alone. Bile is really a waste substance thrown off by the liver, but on its way out of the body it helps greatly in building up the body. The bile and pancreatic juice enter the small intestine at nearly the same place. The liver is really a wonderful organ. Besides making bile, it aids in various other ways in the digestion of food. It also helps to keep the blood pure by removing from it harmful substances that are formed within the body. The liver also acts as a wide-awake sentinel, in that it destroys many of the disease germs, or microbes, that find their way into the mouth and stomach along with our food. If in healthy condition, the liver will kill germs that might otherwise cause such diseases as typhoid fever, malaria, or *la grippe*. If any of these little germs, or any other poisons, such as the poisons of poorly canned meats or vegetables, are swallowed along with the food, they are also taken up with the food, and carried by means of the blood tubes into the liver. The liver works hard to keep these poisons from going any farther along the blood tubes to other portions of the body, and thus guards the rest of the body from the effects of the bad food. If the liver gets out of order it sends but little bile, instead of the quart a day it should send into the intestines.

Poisons are then permitted to pass by unattacked, and the pancreatic juice cannot do the full work of digestion allotted to it. As a result of a disordered liver we have a rather common form of sickness known as biliousness.

Movements of the Intestines.—As the mouth by its movements in chewing the food fine, and the stomach by means of its movements in churning the food about, by rocking it to and fro, from side to side and end to end, so in a similar way the small intestine makes certain movements that mix the food with the bile, intestinal, and pancreatic juices, and forces it farther along the digestive tube or food canal. As the food goes farther and farther along the small intestine, it becomes more and more liquid, until, at the end, only indigestible portions remain, such as unripe fruit, seeds, peelings, large pieces of food that were not chewed fine enough, and husks of grains, like the covering of the separate grains of sweet corn, peas, beans, and the coarser forms of cracked wheat or oatmeal. These waste portions remain solid because the juices cannot act on them and digest them. At this stage of digestion in the small intestine, the food looks somewhat like milk with the undigested particles mentioned above floating in it. This food is still in reality

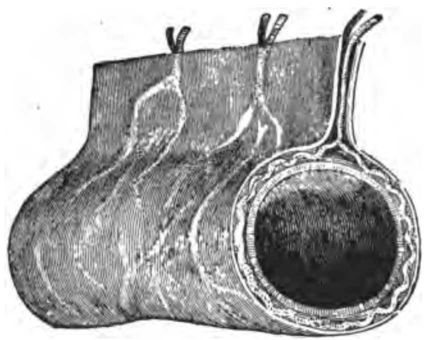


FIGURE 5.—Cross section of Small Intestine, showing the three layers.

outside of the body almost as much as if it were still untouched on your plate on the dinner-table. It must pass through the walls of the intestine and get into the blood, and then be carried to the various parts of the body, before it really becomes food for the bones, nerves, and muscles.

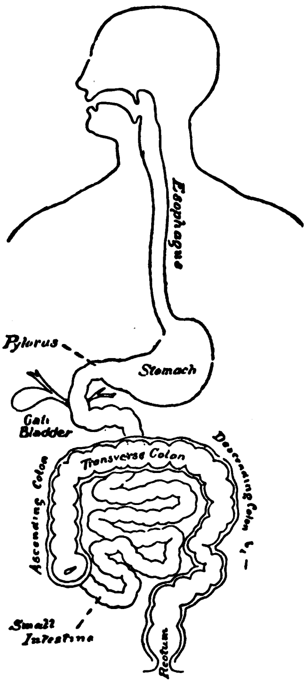


FIGURE 6.—Showing the Digestive Tube, or Food Canal.

Absorption of Food.—As the food is passed slowly along the small intestine, its liquid parts soak through into the blood tubes, and by the time it reaches the large bowel, or colon, most of the water and all of the useful particles have been removed and carried away by the blood, and only the waste matter, such as seeds, hard portions of unripe fruits, peelings, husks, and the like, mentioned above, remain behind. This is driven on and out of the body. These waste portions, that naturally find their way into the large bowel, should be expelled at least once a day, in order to insure good health. If this is done regularly at a certain time, for example, at about the same hour each morning, the bowels form the habit of always acting at this time. If this waste matter is not given off, we have sick-headache, a feeling of heaviness, and may become ill, for these waste substances are sure to poison the body if retained.

You see, then, that there are at least five important organs of digestion. The mouth, the stomach, the intestines, the pancreas, and the liver. Food is softened and prepared for digestion by these five organs by first being properly cooked. Cooking is the first step in digestion. Will you also please remember that there are five digestive fluids: saliva, gastric juice, pancreatic juice, bile, and intestinal juice?

REVIEW QUESTIONS.

1. Why do we eat?
2. Why should we eat several kinds of food?
3. What is digestion?
4. Why should our food be properly cooked?
5. What important fluid in the mouth aids digestion?
6. Why should we eat slowly?
7. What is the stomach like?
8. How long does it churn the food?
9. What important juice in the stomach is necessary to digestion?
10. Why should we eat regularly, and not between meals?
11. What part of the work of digestion is done by the intestines?
12. What help is given by the liver?
13. What juices combine to digest the food in the intestines?
14. How is the food carried through the body to its different parts, after it is digested?

CHAPTER II.

HEALTHFUL AND UNHEALTHFUL FOODS.

We have learned that digestion is the process by means of which the food we take into the mouth is changed into liquid form, or a state of solution, suitable for being absorbed into the blood. This change may be rapid or slow, according to the nature of the food-stuffs the digestive juices are called upon to dissolve. We all know that it takes much longer to digest a piece of beefsteak than it does a cup of beef tea. We know that milk is more readily digested than roast pork or boiled cabbage. When a person is not very well, when we wish to save labor for the digestive organs and make digestion as easy as possible, the person is placed upon a "liquid diet." How does this help to save work for the digestive organs and digestive juices, when they are not in good, healthy condition?

You have observed that some animals seem to be eating all the time. The hen appears to be continually picking up seeds of weeds and grasses, grains of wheat or corn, and countless little bugs, as she goes about the yard. Other animals eat large quantities of food at one time, and then lie quiet and sleep for days. I saw a very large snake—a boa constrictor—at one of the parks the other day, that eats only once in two or three months; but when he eats it takes a very large meal to satisfy him—several chickens, a number of rabbits, and a small army

of rats and mice. Other animals, such as the dog, do not chew their food at all. They tear it apart so that the pieces can just be gotten into the mouth and swallowed, and that is all. The stomach and intestines of a dog have thicker and tougher walls, and the digestive juices have more power. That is the reason that dogs can even digest bones which they frequently swallow. You have noticed that the cow will chew her food only a little at first. Notice how fast she eats the grass in the pasture and see how quickly she swallows it. Then while she is resting she brings the food back to her mouth again, and chews it finer. Deer also do the same. It is called "chewing their cud." Once my little girl, when about three years old, saw some deer in one of the city parks chewing their cud; she turned to me and said, "What do deer chew gum for, papa?" Cattle have four stomachs, one of which is called the paunch and is very large. In the full-grown ox it will hold two bushels. The fourth stomach is nearly like man's in size and shape, and is really the true stomach, for it is the one in which most of the stomach digestion takes place. The other three are little more than storehouses and passageways for the food.

Even some of the small insects have a stomach and intestines which secrete digestive juices. In most worms the digestive tube passes straight through the body. Oysters and clams also possess a stomach and coiled-up intestines. The soft, dark-colored substance at the back part of an oyster or clam is the liver.

Kinds of Food.—Some animals can live on just one kind of food. The cattle on the range will live and fatten on fresh or dried

grass alone. The horse will do the same; only he should have oats or corn in addition to grass or hay, if he has to work hard. A squirrel likes the kernels of nuts and some of the grains, but does not care for grass. A boy or girl eats *more kinds of food* than any other animal. Man requires a great variety of foods. He eats vegetables for one purpose, meats from some of the animals for another purpose, and could not live in a healthy condition if he did not have some food, such as salt, from the mineral kingdom.

Different Foods in Different Countries.—In traveling over the earth, we find the people of one country eat things as food that people of other lands could not bear to eat at all. There are people who eat bees and grasshoppers; others eat rats, mice, bats, and lizards. In some of the French restaurants roasted snails are regarded as a choice article of food, while to most people they are repulsive. A man who used to chop wood for heating the schoolhouse in which I first taught, used to find nests of black ants taking their long winter sleep in their curiously made houses in the chunks of wood. He would eat the ants with his bread at lunch with great relish. Yet this same man would never eat nice, ripe strawberries, for he said they made him ill. He was certainly a queer fellow, and I am sure his tastes differed from yours as well as my own.

Conditions That Modify the Demands for Foods.—The habits of life, as well as the character of the climate, make a great deal of difference in the kind and amount of food eaten. The active man who is working hard at some heavy, muscular labor out of doors, especially in winter, requires a larger amount of food, consisting of a great deal of meat, than does a person

whose work is not so hard. You have heard people say when they were very hungry, that they could "eat like a wood-chopper." And we will all agree that the hard-working wood-chopper and miner require more food than would the tailor seated in his shop, or the clerk in a dry-goods store. The miner, the woodman, and the stage-driver are exposed to cold, rough weather, while the clerk, the tailor, and the newspaper editor are sheltered within doors during their work, which, in addition, does not require as much physical energy as does the heavy work the others do out of doors. An Eskimo in the cold, frozen North can eat fifteen pounds of meat a day, to which he often adds larger quantities of fat or blubber. I have been told by Lieutenant Schwatka, the Arctic explorer, that he has seen an Eskimo eat as much as thirty-two pounds of meat and several tallow candles in a single day.

Bodily Heat.—In this connection we must remember that to keep the bodily functions in proper working order, it is necessary that the body keep up a certain degree of heat. You have seen plants killed by the frost and withered by the heat. So the different tissues of the body will die if the bodily heat falls below or rises above a certain degree of temperature. Thus a fever is dangerous, because in conditions where the disease brings on a fever, a higher temperature is kept up than is good for the body, and little portions of nerves, muscles, and other tissues wither and waste away as truly as does the young, tender plant when exposed to the burning heat of a summer's sun. The heat of the body should be kept at an average temperature of 98.6 degrees F. (37 degrees C.) if we are to remain in a state of health. One method of keeping the body from losing too

much heat is to dress in heavier or warmer clothing. But in the cold climate of the frozen North not enough clothing could be put on the body to keep up the heat to the point it must be to continue in perfect health. Another way to keep up the proper temperature is for the body to use more fuel. That is, more food of the heat-making kind must be used. Now meats, especially fat meats, are heat-making foods. Thus, in our severe winters, men working out of doors, exposed to the cold, rough weather, must eat more meat than they do during the warm weather of the summer. More pork, especially the fatty portions, such as bacon, is eaten in winter than in summer. The body needs it to keep the temperature sufficiently high to have healthy work done by the organs. So, in the Arctic regions, the Eskimo or Laplander, even if he is clothed in the warm furs of the animals he kills, must of necessity eat large quantities of meat, and it is well known that the fats are especially beneficial to him in keeping up the proper degree of bodily heat. His body demands fats and oils just as the bodies of the people living in tropical regions demand fruits for their cooling effect. A dozen tallow candles are naturally more highly prized as food by the Eskimo than a dozen nice, juicy oranges. His body requires meats, fats, and oils; and so he hungers for them just as the miner or sailor longs for fresh vegetables after living for months on salted meats and canned goods. This need of his body causes the peculiar form of hunger of the Eskimo, and this must be satisfied, at least in a measure, to have the degree of bodily heat so necessary to health.

In stubborn fevers, such as typhoid, which cannot be driven away by the usual drugs and medicines, the heat must

be reduced by severe measures. The sick person having typhoid fever must often have ice packed about his body, or at least be frequently sponged with cold water, to reduce the fever before it destroys the tissues of the body. If this is not done, such a high degree of heat is kept up that parts of the body are actually consumed. In typhoid fever the tissues of the intestines are in greatest danger, for often the temperature cannot be lowered by even the most severe measures in time to prevent holes or perforations being actually burnt through the walls of the intestines, and death frequently results.

Different Amounts of Food Required.—If you live on a farm, you may have noticed that some horses are "easily kept." By this is meant that some horses require but little food to keep them plump and in good condition to do their work. There are other horses that eat a much larger quantity of hay and grain, and do no more work, and yet are so poor and bony that their ribs show. Some pigs can be fattened for the market more readily and on a smaller amount of food than others. There are turkeys that can never be made plump enough for a Thanksgiving dinner, no matter how much they are fed. Some persons require a very small amount of food to keep them alive and in good health, while others seem to require a larger quantity. A boy or girl in good health and growing rapidly should have more food than one who has passed the period of rapid growth, because it is needed not only to repair the loss of waste and worn-out particles of the body, but to supply the demands made upon the blood on account of the increasing size of the organs.

Healthful Foods.—We are now ready to talk more particularly about the various foods the body needs. By healthful foods we mean those that assist best in the repair of waste tissue and are more helpful in promoting the growth of the various parts of the body. Unhealthful foods are those that are harmful. They are such as do not help the growth and repair of the body. To sum up the whole matter we can say: *Food is anything which taken into the body supplies it with heat, weight, or strength.*

You have already learned that we eat a greater variety of foods than do other animals. You know that our foods are obtained from minerals, plants, and animals. As you think of your breakfast, what foods did you eat that came from animals? What from vegetables? What mineral substance did you eat?

MINERAL FOODS.

Salt.—This is the chief food from the mineral kingdom. Salt is present in every part of the body except the enamel of the teeth. If we do not take salt with our food we suffer greatly, since it is so necessary to the body. In nearly all the foods we use, salt is naturally present in small quantities. Vegetables in growing take up salt from the soil. All the meats contain a little salt absorbed from the blood of the animals. But the salt naturally found in our foods is not enough, so in cooking more salt is added. Sometimes we add it at the table. Food does not taste good if unsalted. A little salt not only makes the food taste better, but it causes the digestive juices to flow, and it creates an appetite. This is a very good illustration of how nature provides for us. Salted

food will cause the "mouth to water," and all the digestive fluids to flow freely, so that it is more easily and quickly digested than unsalted food.

Every stock-raiser knows that animals must have salt to do well. If they are not given any salt their hides grow rough, they become less active, are soon dull and stupid, and finally lose health and strength. Just watch how quickly sheep come at the call of the farmer, if they think they can thus get the salt they crave. Wild animals, such as deer and bear, will go long distances and even risk their lives to get to a salt spring, or "salt lick," that they may secure some of this necessary mineral substance. It is fortunate that salt is plentiful and cheap, since it is so essential to health and strength. It is found in many portions of our country. Can you tell where and how salt is obtained?

Other Mineral Foods.—*Lime*, *soda*, *potash*, and *iron* are taken into the body in various forms, but in very small quantities. A small amount of lime is found in every portion of the body. The bones are more than one-half lime. Altogether there are about ten pounds of lime in our bodies. However, it does not waste and leave the body very rapidly, so we do not have to take more than six grains a day with our food. Your teacher will show you how much six grains of lime are. Soda and potash destroy disturbing acids within the body. This is the reason that in case of a sour stomach or "heart burn," a little pinch of common cooking soda, sometimes called saleratus, will give great relief. Green foods should be eaten, especially at certain seasons of the year, because of the iron they contain. Spinach, lettuce, dandelion greens, and similar foods contain

iron in a form that can be taken up by the blood better than a similar amount of iron taken as a tonic in the form of medicine.

ANIMAL FOODS.

The principal foods obtained from animals are milk, butter, cheese, eggs, and the different kinds of flesh—beef, mutton, pork, fish, fowl, and wild game.

Milk.—Pure, fresh milk is the only perfect food. It is the only food that contains all the elements your bodies most require. Being a fluid, it is very easily digested. Physicians use it more than any other food for people who are sick, because it is so easily digested and has the power of sustaining life longer than other foods. Milk should be kept in a clean room, where the air is always pure. If this is not done, poisonous gases will be absorbed and the milk thus becomes injurious as food. If a pan of milk is placed in an ice-box near a bunch of onions, or in a small room near a can of coal-oil, the milk soon becomes tainted, as you may easily detect on tasting it. In the same way it will absorb poisons from foul air.

In cities milk is often adulterated by the addition of water. Sometimes this water is impure, and the milk is thus made the means of carrying disease germs to our bodies. Some substance, as formalin, is often added to milk by dealers to keep it from becoming sour. In this way old, impure milk is often sold for fresh, sweet milk, and much harm done to the children using it. Because milk is so easily tainted and adulterated, nearly every large city has an army of milk inspectors connected with the board of health, whose business it is to examine all the

milk brought into the city for sale. If the milk is found to be unfit, dealers are not permitted to sell it, and it is destroyed by the inspector. By this method of milk inspection the lives of thousands of little children have been saved in our cities the last few years. Fresh milk is the best kind of food we can take. If its value as a food were better understood, it would be more generally used. It should, however, never be ice-cold when taken into the stomach.

Butter.—Butter is a most important article of food. It supplies the body with much of the fatty material needed. It also gives a better taste to some other foods, making them more readily eaten and more easily digested. Looked at under the microscope, a drop of milk appears as a number of little oil particles floating in water. This oil or fat in milk is called cream. Oil is lighter than water; thus, when a crock of milk is allowed to stand, we know that the "cream rises" to the surface, and can easily be skimmed off to be churned into butter. The process of churning cream consists, then, in the beating of the little fatty particles, or oil drops, into one solid mass, or butter. The buttermilk remaining after churning is a healthful, cooling drink in hot summer time, but it contains very little nourishment.

Cheese.—More nourishment is contained in cheese than in most of the lean meats, but it is very hard to digest. This is the reason that it is not used very extensively as a food. In many parts of Europe it is used in place of meat, especially by laboring people. It is a cheap food, and might well be more largely used by men working out of doors, for their active exercise will greatly assist digestion. If cheese be taken with

a little milk it is more easily digested. This is the reason that "cottage cheese" or "smear-case" is such a wholesome food.

Eggs.—Eggs are very excellent food. They are easily digested when properly cooked, and contain much nourishment. They are most digestible when soft-boiled in the shell, or when "poached" by being broken into a shallow pan of boiling water. Some children do not like the yellow part, or the yolk of the egg, and eat only the white. Thus they do not get all the food elements of the egg, for the white and yolk contain very different food properties. The white contains no fat, but considerable water; the yolk contains considerable fat, or yellow oil, and very little water.

Meats.—The meats used as food are rich in nourishment. They are very desirable because of their pleasant taste as well as their excellent food properties. *Beef* is regarded as the best meat for general use. It is more easily digested than veal or pork. Some of the cheaper beefsteaks, such as round steak, are more nourishing than some of the more expensive portions, tenderloin steak, for example. *Mutton* ranks next to beef, and is a very healthful food if properly cooked. Some people, however, do not like the taste of mutton. Mutton broth, like beef tea, is very nutritious and easily digested, and is, therefore, a very valuable food for the sick. *Veal* is not easily digested. It is not a very good food, for it does not contain much nourishment. As a food it does not compare in value with either beef or mutton. *Pork* is not readily digested, but is more nutritious than veal. It can be eaten only by those who have strong digestive powers, and by those who exercise a great deal. *Fish* contains important food elements. While not quite so

easily digested as meat, it can in a measure take the place of meat as a change. People used to think it a particularly good brain food, but the brain is really nourished by the same elements as the other parts of the body. Fish, therefore, is not nearly as nourishing for the brain as a good beefsteak would be. Fish should always be eaten when fresh, for it is very quick to decay. Salted fish, like any salted or "cured" meats, are more difficult to digest than fresh, and yet salted codfish is a very excellent food, being nourishing and at the same time cheap. We find *shell-fish,* such as oysters and clams, very good for food, more especially when eaten raw. When cooked they are harder to digest. When raw, their own juices assist a great deal in their digestion, and by cooking, these juices are so changed as to be of no use whatever in digestion. Because of their easy digestion, fresh, raw oysters are an excellent food in sickness. Crabs and lobsters are harder to digest than oysters, but when well cooked are good food.

Animal and Vegetable Foods Compared.—It is now a well-known fact that almost all animal food is more easily digested than vegetable food, and should be used by children and sick persons, whose organs of digestion are not as strong as those of grown persons in perfect health. Growing boys and girls need some meat, and should have it, or eggs, at least once a day. Of course it is possible to live a healthy life without eating meat, but vegetables are by no means the best kind of food. Animal food contains practically no starch, and as the vegetable foods are rich in starch, some vegetable foods must be eaten in order to supply the body with the starch and sugar so much needed.

VEGETABLE FOODS.

Bread.—While bread is sometimes called the "staff of life," it is not a perfect food when used alone. It contains very little fat in proportion to the amount of starch. Bread is half starch, and only one-seventieth fat. Butter must be added to make it a complete diet. So while bread may be the staff of life, bread and butter together are "a gold-headed cane," as some-one has said. Cheese, being rich in fats, may take the place of butter. In some of the countries of Europe, black bread and rich cheese form the main articles of diet of the peasants. Together they make a fairly complete and very nourishing food. With milk, bread is also a valuable food, especially for the young. Bread made of *whole wheat flour* contains more food elements than the flour used to make white bread. Newly baked bread is very difficult to digest, since it is apt to form such a soft, pasty mass in the mouth that by the time it reaches the stomach it is a solid lump which the digestive juices cannot easily enter and dissolve.

Potatoes are a good food with meat, but hard to digest. They contain no fat. In fact, potatoes alone do not constitute a very complete food. They should be eaten with butter, meat, or meat gravy. *Beans* are a valuable food for a strong, healthy person, but persons with weak digestive organs should not eat them. When either beans or peas are used, they should be cooked a long time, and in eating them, one should be very careful to see that they are thoroughly chewed. The cereals, as oats, corn, and rice, are chiefly starch. Rice contains about ninety per cent starch. Corn contains more fat

than the other grains, but all vegetable fat is hard to digest, and is of little value as food. *Turnips, cabbage, parsnips,* and other vegetables give variety to our list of foods. They are all difficult to digest, and contain very little nourishment.

Fruits.—All fruit is hard to digest. Apples, pears, grapes, peaches and similar fruits really contain but little food. They contain some sugar, a slight amount of mineral matter, and the acids that give them their taste. These acids, in a measure, stimulate the appetite and promote the flow of saliva and gastric juice. The main use of fruit does not consist in the real food contained, but in the fact that it is not digested but carried down the intestines quite rapidly, thus sweeping along before it refuse food and waste substances that have accumulated, thereby keeping the intestines clean and in good condition. Ripe fruits in their season are the most beneficial, while too ripe or unripe fruits often cause illness. Much of the danger of unripe fruits may be removed by cooking. Green vegetables, such as raw cabbage, lettuce, radishes, beets, and celery, act like fruit and are similar, but they contain even less nourishment than fruit. A great danger in eating much fruit is that it may sour and decay in the intestines, just as it does outside the body. When this occurs, as is often the case, severe, painful illness arises, as this decayed fruit in the bowels is very poisonous. *Nuts* are often highly praised as foods because they contain more fats than do other vegetable foods, but the fat or oil contained in nuts is especially hard to digest. *Spices,* such as mustard, pepper, and cloves, burn the stomach just as they burn the mouth. If we put mustard on the skin it will make the skin red. Spices do not nourish the body in

any way, and therefore are not food. Having no value as food, they are often used to season bad food, and to cover up the taste of injurious foods, and in this way they may also prove quite harmful.

Candy and Preserves.—These contain chiefly sugar. A certain amount of sugar is needed by the body, so a limited amount of pure candy is healthful. The harm arising from eating candy lies in the fact that it is apt to be eaten between meals, when the stomach should be given a chance to rest. Again, too much candy may be eaten at one time. Whether in the form of candy or other sweets, excessive amounts of sugar cause the liver to be overworked and a bilious attack results.

Time Required for Digestion.—You have noticed that some foods are easily digested while others are quite difficult of digestion. Some foods are not good, especially for young, growing persons, because they require too much time for digestion, thus giving the stomach little or no opportunity for rest. The time required for stomach digestion was first discovered in a very interesting and peculiar way. A man by the name of Alexis St. Martin had an opening from the surface of his body directly into the stomach, as the result of a gunshot wound, so that the stomach could be looked into, and the time required for digesting the various foods could be closely observed and studied. Other cases, similar to that of St. Martin, have since occurred, and more observations have been made, so that we know that stomach digestion requires from one to four hours as shown in the following table:

	HRS.	MIN.		HRS.	MIN.
Rice, - - -	1	00	Beef, broiled, - -	3	00
Pigs Feet, soused, -	1	00	Mutton, boiled, -	3	00
Venison Steak, broiled,	1	30	Mutton, roasted, -	3	15
Salmon Trout, boiled,	1	30	Oysters, fried, - -	3	30
Apples, sweet, - -	1	30	Potatoes, boiled, -	3	30
Milk, boiled, - -	2	00	Eggs, hard boiled, -	3	30
Codfish, salted or cured,	2	00	Pork, broiled, - -	3	30
Tapioca, - - -	2	00	Beef, fried, - -	4	00
Cabbage, raw, - -	2	00	Salmon, boiled, -	4	00
Goose, roasted, -	2	30	Ducks, roasted, -	4	00
Oysters, raw, - -	2	30	Cheese, - - -	4	00
Potatoes, baked, -	2	30	Cabbage, boiled, -	4	30
Chicken, boiled, -	2	45	Pork, fried, - -	4	30
Turkey, roasted, -	2	45	Veal, fried, - -	4	30
Beef, roasted, - -	3	00	Pork, roasted, - -	5	20

Cooking.—You have already learned that cooking is the first step in the process of digestion. By cooking, our food is rendered soft so as to be easily chewed. Cooking, as a rule, also improves the taste of the food so that it is more agreeable. It also destroys many of the disease germs that lurk in food. Cooked food, then, should taste well, and be soft or brittle, so that it can be chewed fine. If food remains tough, it is not well cooked, or it was unfit in the first place. Improper cooking may make what would otherwise be the best foods harmful to us. There are three good ways of cooking—broiling, roasting, and boiling.

Broiling is the best way in which to cook meats. Roasting is the next best, and boiling comes next. Frying is apt to make the meat hard and dry, and therefore difficult of digestion. When food is to be fried, great care should be taken to

have the pan itself, or the lard or butter, if they are to be used, very hot before the food is placed in it, and kept hot until cooked, so that as little fat as possible may be absorbed by the food. In cooking meats, the natural juices should be kept in them as much as possible. In broiling a beefsteak over a hot fire the heat almost instantly seals up the meat so that the juices cannot escape. In boiling, the meat should be placed in boiling water, and roasts should be placed in a very hot oven in order that the juices may be retained. If, however, we wish to make soups, such as mutton or beef broth, we then desire to use the meat juices rather than the meat itself. In this case the meat should be cut into small pieces and placed in cold water, and then gradually brought to the boiling point. In this way the nourishing juices are extracted. Cooking is an art that should be carefully studied, in order that our food may be so prepared as to do the most good.

Adulteration of Foods.—Many of our foods are sometimes spoiled by persons who manufacture or sell them, putting into them cheaper substances that are dangerous to health. Such persons seem to care little for the purity of foods, but are chiefly interested in making the most money possible out of them. So common has this adulteration become that in most of the states the law-making power has passed pure food bills to prevent the sale of such adulterated articles. These laws are most worthy and should be strictly enforced, for what is money-making by a few individuals compared with the health of the people of an entire city or state, which may be greatly endangered by the use of these impure or adulterated foods? The foods most often adulterated are sugar, candy, syrup, milk,

butter, chocolate, coffee, flour, baking powder, bread, and jellies. Sugar, syrup, and candy are sometimes made from corn by a peculiar process, by means of which the starch of the corn is changed into glucose, and a kind of sugar not so sweet or healthful as sugar made from sugar-cane or sugar beets. This sugar is quite apt to ferment, or sour, and decay within the bowels, thus causing disease. Some candies are colored with poisonous matter. The plain, cheap candie are, as a rule, the purest and most healthful, as it is the high-priced confections that are the most frequently adulterated.

Milk is often adulterated by the addition of water and some white substance, such as chalk. This not only thins the milk and makes the same amount less nourishing, but at the same time the water thus added is often impure, and in this way disease germs are added to the milk, causing sickness and death.

Butter is sometimes made entirely from lard, tallow, and cotton-seed oil, to which coloring matter is added to make it look like pure, yellow butter made of rich cream. This product is called *butterine*, or *oleomargarine*. It can be sold for about half what good butter would bring. If the lard or tallow is obtained from diseased animals, the butterine made from it is apt to prove very injurious. If cleanly made from pure lard or tallow, it is not so harmful and may be used without danger, especially in the place of "cooking butter." But when so made there is not so much profit in selling it as when made from cheaper, unclean materials. Almost all of the states have laws against the sale of butterine, without its being so stamped as to plainly show to the person buying it that it is not genuine butter, but an imitation. Such laws are right in protecting the

people against false or counterfeit foods, and in preventing people from being imposed upon. Has your state such a law?

Chocolate, coffee, and flour are adulterated in various ways. The chief way of adulterating flour is to add very fine corn meal or corn flour. This is heavier than pure wheat flour, and as flour is sold by weight, the person buying it is cheated. Besides, the fine corn flour added is not so nourishing as the same amount of wheat flour would be.

Bakery bread and cake are often made impure by the addition of ammonia for the purpose of making the loaf lighter and whiter. Not only is ammonia injurious, but a loaf of bread made in this manner weighs less than the same sized loaf would if made without such an ingredient. Consequently the customer does not get the same amount of nourishment from a five-cent loaf of bread made with ammonia that he would in a similar loaf made without it.

Baking powder is often made impure and harmful by the addition of alum. Any baking powder containing alum is injurious. You know how home-made jellies and preserves taste. They are also wholesome foods. When made from the pure juices of fruits and pure sugar they are expensive. On this account much jelly is sold at a low price, made from a brittle, glue-like substance called gelatine, to which acids are added, besides some unhealthful coloring matter to make them look like the pure jellies made at home from currants, strawberries, grapes, and other fruits.

Perhaps you have heard people speak jokingly of wooden nutmegs, hickory hams, and oats made by whittling shoe-pegs, all said to be the invention of the ingenious Connecticut Yan-

kee of fifty years ago. But these are as nothing compared with the food adulterations of to-day, which are so skillfully carried out that detection of the adulteration is difficult. They grow out of a general demand for cheap things, and when the genuine article cannot be supplied at a profit, we find some skillful adulteration taking its place. In addition to those already noted, please observe the following list. Not only do we have artificial eggs, artificial butter and adulterated wheat flour, but we have buckwheat adulterated with wheat middlings, cider vinegar distilled from grains, lemon extracts made without lemon oil, and vanilla extracts without a trace of vanilla. We buy "Vermont Maple Syrup" that never was within a thousand miles of Vermont, but was made in a little, dingy city factory. Milk is robbed of its cream, filled with lard, and sold all over the world in "American Pure Cream Cheese." Nearly all of the cheap strained honey is made without the effort of a single bee. Artificial smoke is made out of poisonous drugs, for the purpose of quickly curing hams and bacon. Oysters are partially embalmed with chemicals. Spices made from ground pepper hulls, ground cocoanut shells, and ground bark are manufactured and sold by the ton. Canned fruits are often preserved with antiseptic drugs which interfere with digestion. This is only a partial list, but it is enough to show that we are oftentimes cheated in buying food.

The adulteration of food is wrong, and people are right in insisting that laws be passed to prevent the sale and use of impure foods.

Diseased Foods.—Animals become sick, and when in this condition are sometimes killed, and their parts sold as food.

Vegetables may also be diseased. Such meat or vegetables are never good for food. Dishonest dealers will sometimes sell them to those who are not aware of their condition, and thus cause illness and sometimes death in the persons eating them. Diseased food is as bad as decayed or spoiled food. Consumption is often caught by persons eating the meat from diseased cattle, or drinking milk from cows having this disease. Of the different meats, pork most often contains disease germs. Meat should never be eaten raw. It should always be well cooked, as the heat employed in cooking will destroy any germs of disease that might be lurking in the meat.

FIGURE 7.—Diseased Pork, highly magnified, showing Trichinæ.

Other Harmful Foods.—Food which is decayed or spoiled, and thus tastes musty or tainted, is always unfit, and may even be poisonous. Spoiled milk is perhaps the worst of all. Young children should never drink milk which is the least bit sour. Moldy bread, tainted meat, or decayed fruit should never be eaten. Meat which is pale, yellowish, or very dark, is unhealthful. Canned foods, especially canned fish, canned beef, potted ham, tongue, and similarly prepared meats, spoil very quickly after being opened and exposed to the air. Any

canned food should be eaten the same day it is opened. *Unripe foods,* whether fruits or vegetables, are unfit, more particularly if they are not cooked.

Partial Starvation.—A very good illustration of what is meant by partial starvation is found in the experience of many sailors and some of the unfortunate miners in the Klondike. Men, in their rush to the gold fields of Alaska, in selecting the food supply to be taken out with them seemed to consider only the amount of space such food would occupy on the crowded boats, or what it would weigh when they "packed" it over the trail. Many of them did not consider at all the question of health. Therefore the meats selected were either salted, smoked, cured, or dried. These would have been all right if other necessary foods had also been taken along, but a constant diet of salted or cured meats, without the counteracting acids of fruits, produces the dreadful disease known as "scurvy." The life of many a poor fellow that died of scurvy in the gold fields, would have been saved, if with the salted meats and canned goods upon which he made his meals, he had occasionally taken some juice of the lime or lemon. Sailors found this out long ago, and the ship's doctor always has on hand a good supply of these acid juices with which to prevent scurvy. Scurvy is a disease resulting from a form of partial starvation.

It is certainly true that every person requires not only a certain amount of food, but also a variety. The kinds of food which the body demands and must have, fall into four groups:

1. Proteids.
2. Fats.
3. Carbo-hydrates.
4. Salts.

Proteids are necessary food elements, and are found in such foods as beef, mutton, eggs, milk, and cheese. The proteids are tissue formers. No new tissue can be formed in the body without them; so lacking these, growth is impossible. Milk is the best food for children, because it contains several proteids. Eggs and meat should be added as soon as children are able to properly chew and digest them. It is a positive fact that the diet of children should be *more* nutritious, instead of *less* nutritious, than that of adults. If there are not enough proteids in the child's food he suffers from partial starvation. This lack of food with respect to quality occasions starvation of the body as truly as a lack of the proper amount of food. Many children suffer from *proteid starvation.*

The *fats* include such foods as butter, cream, the fatty substance in milk, and the fats of meats. In proportion to the whole amount of food eaten, the child requires more fat in his food than does the adult. Children often suffer from *fat starvation.* Growing bone needs fat, and that is one reason that children require so large a proportion of fat in their foods. We must repeat what we have said before in this chapter, that the fats derived from animals, such as rich milk, butter, and fatty meats, are much more easily digested than the vegetable fats.

The *carbo-hydrates* include such foods as starch and sugar. These are as necessary to complete feeding as are the proteids and fats. The carbo-hydrates are usually fed in abundance to children, as they constitute the chief element in wheat, crackers, oatmeal, and bread. *Carbo-hydrate starvation,* then, is not very common, except that some children do not get enough sugar.

The *salts* include common salt, lime, soda, and potash. These we have already mentioned as necessary food elements.

To sum up in a general way our talk about healthful and unhealthful foods, we must say that every particle of food that enters the stomach either benefits or harms the body. The amount of strength we have, the quality of our health, and the bodily heat all depend upon the kind of fuel we use in the machinery of our bodies. Many diseases are due to improper food. Each pain you have is a little signal notifying you that somewhere in your body there is either a *lack* or *excess* of supply.

REVIEW QUESTIONS.

1. When a person is sick, why do we give him much of his food in liquid form?
2. Why are different kinds of food eaten in different climates?
3. How is the bodily heat kept up to the proper degree?
4. Do all people require the same amount of food?
5. What is meant by healthful foods? By unhealthful foods?
6. What foods do we get from the mineral kingdom? From animals? From the vegetable kingdom?
7. Why is milk called the only "perfect food"? What is the necessity for milk inspection?
8. What is the food value of butter, cheese, and eggs?
9. How do the different meats compare as foods?
10. What is the comparative value of animal and vegetable foods?
11. Are fruits eaten simply for their food properties?
12. Why should our food be properly cooked? What are the different methods of cooking?
13. What is meant by adulteration of foods? Give illustrations of food adulterations.
14. What is meant by "partial starvation"?

CHAPTER III.

OUR DRINK.

If a boy or girl weighs one hundred pounds, it is estimated that 70 per cent of this amount is water. Nearly three-fourths, then, of the weight of the body is due to the water it contains. If all the liquids and moisture could be dried out of your body, it would shrink up so as to be surprisingly small. Pure drinking water is necessary to life and health. The body naturally craves water more than it does food. A person can live longer without food than without water. Water is the only substance that will quench thirst. Other drinks, such as milk, tea, and coffee, consist of water containing certain solids, and do not quench thirst so completely as water.

We know that the liquid part of the blood carries the food we eat to all parts of the body. This liquid in the blood comes from the water we drink and the water contained in the foods we eat. You can see the water in fruit, for it is the water that makes the fruit juicy. Water constitutes one-half of the weight of beef, and three-fourths of the seemingly dry and mealy potatoes we eat. Milk is nine-tenths water.

Uses of Water.—The chief uses of water to the body are: 1. To soften the food in cooking. 2. To form the liquid part of the blood, and thus carry food in the blood to all parts of the body. 3. To take up and remove the waste elements in

the tissues of the body. 4. To carry away from the skin on the surface of the body, by means of sweat or perspiration, impurities and extra heat that may arise from food or exercise, thus keeping the temperature of the body at a healthy point.

Pure Water.—The water we drink, as we find it in nature, always contains more or less mineral matter, some gases, and occasionally some vegetable matter, and even small animal organisms. Absolutely pure water is not found in nature. It can only be made absolutely pure by distilling it. But distilled water is unpleasant to the taste, being flat and insipid. When the mineral matter, such as lime, soda, potash, or even sulphur is not in excess, it is useful to the system. We know lime is important in the formation of the teeth and bones; therefore water containing a small amount of lime benefits the body, especially when it is growing. Water sparkles because of the gases contained. Water containing no air or gas tastes unpleasantly flat. Some substances found in water are harmless and even beneficial. Other substances you will find are harmful and dangerous to health. You can plainly see that it is just as necessary for our health that our drink should be pure as that our food should be pure. People should never drink water that is taken from a well located near a slop-hole, cesspool, manure-soaked barn-yard, or other filthy place.

Impure Water.—It is a great mistake for people to think that water gotten from any kind of a well is good for drinking purposes. Many people are not careful as to the location of the well, often digging it in some low place where they can get water most easily. When located in a low place, impure surface water draining off the soil will often flow or seep into the

well, thus making its water impure. No mistake can be more serious, if we value our health, than to locate a well in a poor place. A well to supply drinking water should not be located near a barn, and should be at least fifty, and better still, a hun-

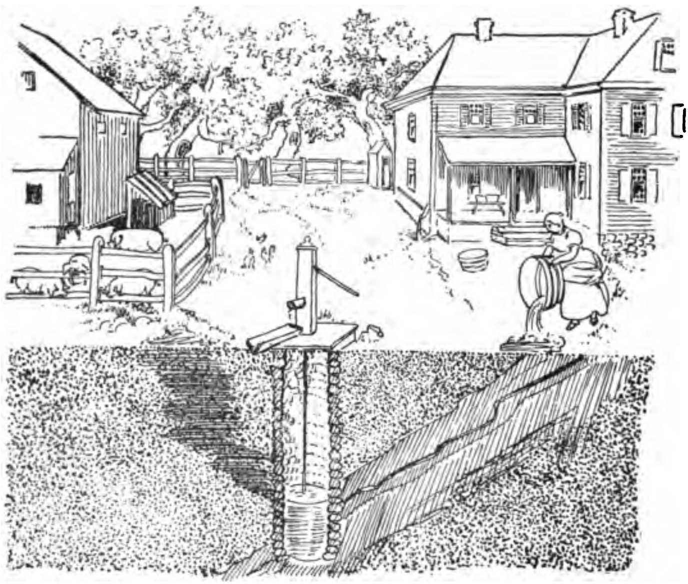


FIGURE 8.—Showing how water may become impure in badly located wells, from surface drainage.

dred feet from any cesspool, drain, or other place where slops and refuse are thrown. It is also best that the well should not be in the house. We must remember that germs of disease may be carried through the soil for quite a distance, especially if there is a stratum of rock sloping toward the well. Wells

dug in gravelly soil are often better than those that are sunk into rock, for impurities may be carried a long way through the cracks or crevices between layers of rock. As a rule, water from deep wells is purer than water from shallow wells. Driven wells are the best. They are made by driving iron pipes into the ground, until they pass a layer of rock or stratum of clay, commonly called "hard pan." Water reached under such a stratum of rock or clay is not so apt to be impure as that found nearer the surface, which may be made impure by drainage and seepage.

Disease Germs in Water.—Sometimes upon examining drinking water under the microscope, or analyzing it by the methods of chemistry, we discover that it contains decaying animal or vegetable matter, and also little animals so small as not to be visible to the naked eye. These dangerous little animals are called *germs*. Though they are the smallest forms of life known to exist, they are the most dangerous enemies known to life and health. Why are these minute animals so dangerous? 1. They are very industrious little fellows, and their chief business is to manufacture poisons of a very deadly character. 2. They increase in numbers with great rapidity. Some kinds of these germs develop so rapidly as to double in number *every fifteen minutes.* Think, then, of the immense number that might develop at this rate from a single germ in twenty-four hours. They are also tough little fellows. Some of them cannot be killed by extreme cold. If water containing them is frozen into ice, many of them will stay there for months, and then when the ice melts, and they are thrown out again, become active poison makers. They can, however,

be killed by boiling the water containing them. Typhoid fever, diphtheria, yellow fever, and cholera are the most deadly of the common diseases that may be "caught" by the presence of germs in water.

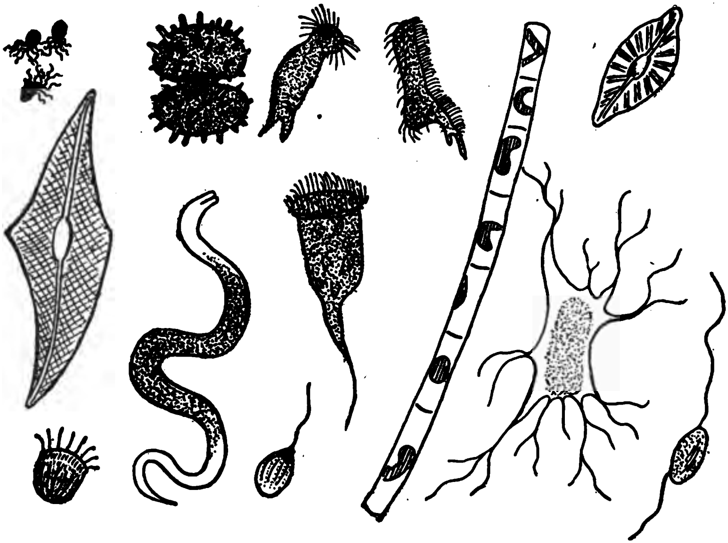


FIGURE 9.—Organisms found in impure water (highly magnified).

Impure drinking water thus causes a great amount of sickness. Investigations by the boards of health in many states and cities show that thousands of deaths occur every year because of impure water supply. The disease germs in the water supply of an army often cause many more deaths than the bullets in battle. To escape typhoid fever and similar deadly diseases we must be certain that our drinking water is

free from every kind of filth. In one of our large cities recently, hundreds of people died from typhoid fever, which was found to have been spread by milk cans having been washed in impure water containing these disease germs.

To Purify Water.—The only way to purify water containing germs is by boiling. This is especially necessary in large towns and cities where it is sometimes quite difficult to secure good, pure drinking water. Filters strain some of the impurities out of the water, and by their use muddy water may be made to look quite clear. But no filter is fine enough to strain out the little disease germs. No filter is germ proof. Boiling is the only safe method of purifying water.

Mineral Waters.—When much mineral matter is present, the water is called mineral water. Many such waters are found in various springs over our country, and some of them are excellent in healing certain diseases. The chief mineral substances found in them are lime, soda, lithium, iron, potash, sulphur, and salt. Some of them contain so much pure salt that they furnish much of the salt we use in cooking and on our tables. Can you tell the difference between *hard* and *soft* water?

Lead and Zinc Poisoning.—There is good ground for the objections we hear against lead pipes for the carrying of drinking water. The small amount of mineral matter in the water may attack the lead and thus form a deadly poison. The danger increases the longer the water is permitted to stand in the lead pipe. In using water from lead pipes, it is best to allow the water to run or be pumped long enough for all that has been standing in the pipe to run out, and fresh water to enter from the well or water-main.

Water as a Beverage.—Pure water is the best beverage a person can use. Persons with stomachs too weak to bear tea or coffee are greatly benefited by drinking a cup of hot water instead of these beverages. Beverages other than water are good just in proportion to the amount of water they contain, and the harmlessness of the other substances found in them. Pure lemonade, made of lemon juice, sugar, and water, is a wholesome drink, but the red lemonade of the circus, and the bright-colored "soda-pop," often contain harmful coloring matter and injurious acids that are used in place of lemon juice just because they are cheap. Thus drinks may be adulterated in much the same way that foods are.

It is not wise to drink too much water with our meals, for in so doing we are apt to weaken the digestive juices to such an extent that our food will not be properly treated in the mouth, stomach, and intestines. Stomach and bowel troubles may result from this cause.

It is also harmful to the stomach to put ice-cold water into it, thus chilling it so it will be unable to do its work perfectly.

Tea and Coffee.—These are often used in place of water, chiefly for the sake of variety. Tea and coffee contain no food. They act in a peculiar way as a sort of whip to the body. They are *stimulating.* A substance that causes the body to do more work without giving to it any extra energy or weight is called a *stimulant.* When you come to study Latin you will find that *stimulus* is the Latin name for an ox whip. It is wrong to whip the body into attempting to do things beyond its strength, just as it is wrong to try to whip a horse into pulling a load much too heavy for it. Tea and cof-

fee act upon the mind in such a way that the tired condition of the body is not felt. They do not increase the strength of the body, but simply deaden the tired feelings. They are injúrious to boys and girls, for they retard growth, and the nervous system of the young person is more readily harmed by a stimulant than that of an older person.

If not taken in too great quantities, or made so as to be too strong, tea and coffee are not harmful to a healthy person over fifteen years of age. When long and hard work *must* be done, or when a person *must* endure great *exposure*, then tea and coffee are valuable stimulants. Thus Nansen and other Arctic explorers, as well as soldiers on long, forced marches, have found them necessary.

Adulteration of Tea and Coffee.—The leaves of various other plants are added to tea leaves and then dried. The "green" teas are often colored with copper, making them injurious. *Chicory* is raised chiefly for the purpose of adulterating coffee. The root is roasted and ground, and it is found in almost all the cheaper grades of coffee.

Beer, ale, wine, cider, gin, brandy, and whiskey all contain alcohol, and are therefore harmful. They can never take the place of water as a beverage because of their injurious effects upon the bodily organs. All alcoholic drinks produce a feverish condition and create a demand for more water than the system naturally requires. They increase rather than quench thirst. The poisonous nature of alcohol is fully discussed in subsequent chapters.

CHAPTER IV.

TEMPERANCE.

There are certain unmistakable laws of right living clearly impressed upon the constitution of man. If he should live according to these laws he would always be strong and healthy. By this time you have learned that the vigor and health of many persons are seriously impaired by neglect. Failure to eat nourishing food, to breathe pure air, to keep the body clean, and to exercise, are frequent causes of physical weakness and disease. There are people whose lives are really shortened because they have failed to spend a few minutes a day in regular judicious exercise. Lack of anything the body needs for healthy growth always works injuriously.

While there are many persons whose health has been seriously impaired because of the lack of those things so essential to bodily vigor, there are many more who have brought lasting injury upon themselves by *excesses* in one or more directions.

Temperance.—Improper eating and improper drinking produce more sickness than all other causes. It seems all the more strange that man of all animals should be the one to indulge in excesses of appetite, when he possesses the most knowledge concerning the ill-effects of such indulgences. Man is surrounded by an abundance of wholesome food, yet he often makes himself sick by excesses in eating and drinking, acting as though he would never again have an opportunity to partake

of food and drink. Such men live to eat, rather than eat to live.

A horse will never drink merely for the sake of sociability, and a squirrel with a house made of acorns will eat just enough for his needs, but some men eat all kinds of foods and drink disagreeable concoctions merely for the pleasure of eating and drinking. *Temperance* is the exercise of moderation in regard to all our appetites. *Intemperance* is the gratification of any appetite or inclination which does not fulfill bodily need.

Intemperance in Eating.—This is one of the most common forms of intemperance. Eating injudiciously never fails to cause bodily derangement of some sort. The injuries of over-eating are shared by all parts of the body—brain, nerve, bone, muscle, stomach, liver—none are exempt from the harmful effects. A child who habitually makes a meal consisting of sweet cake, is intemperate, and he afterwards pays dearly for such indulgence. Not only will he suffer pain, but his organs of digestion become deranged and incapable of doing their best work, and for years he suffers because of his folly. Sometimes when sufficient plain food has been taken at a meal to satisfy the appetite, a man will take something to give him a new but false appetite, or will partake of some rich dessert, highly spiced and sweetened, which he eats merely for the pleasant taste, and not because it contains necessary food elements. A perverted appetite frequently leads us to eat cake, candy, and fruits *between* meals, thus overworking the stomach by giving it no opportunity to rest. If we are hungry enough to eat bread or meat between meals, then the appetite should be satisfied, for

this is a call from the cells of the body for food, rather than from the palate for agreeable taste sensations.

The Alcohol Habit.—The use of drinks that contain alcohol is the worst kind of intemperance. This form of intemperance is a terrible curse in America. It tends to destroy the work that the school strives to build up. The American school has for its object such education of children as will lead them to become good citizens.

Because alcohol enters the body by means of the digestive tube, in the same way in which food does, rather than that it is of itself a food, it is here treated as naturally following the discussion of proper food and drink for the human body. If we eat a sufficient amount of wholesome food to-day, we do not require a larger amount of the same food to-morrow. Not so with alcohol; the appetite for it grows with the using.

Is Alcohol a Food?—You recall that food is any substance which, when taken into our bodies, will produce heat, weight, or strength. Has alcohol any of these qualities which must be possessed in order to class a substance as food? Are its effects neither beneficial nor harmful, or is it injurious to the human body? We will proceed to answer these questions.

Does Alcohol Produce Bodily Heat?—It is often claimed for alcoholic drinks that they possess a special advantage in the readiness with which they are able to produce bodily heat. This is an error. In the ordinary forms in which it is taken alcohol lowers the temperature of the body, as the clinical thermometer of the physician plainly reveals. It is true that a drink of wine or whisky sends the blood to the skin. This is seen in the flushed face. The sending the blood to the skin gives a sensation of heat. We *feel* warmer. We are deceived,

for we are actually cooler. The more blood there is at the surface of the body, the more quickly is its temperature lowered. Alcohol does not create bodily heat.

Does Alcohol Increase Tissue?—Alcohol unites so readily with water that it tends to extract the fluids of the body from the healthy tissues, and in this way it attacks and destroys them. Scientists seem to agree that alcohol is a tissue destroyer and not a tissue builder.

Does Alcohol Create Energy?—This is a question that has provoked much discussion. Renowned physicians tell us there are some diseases in which the *temporary* use of alcohol is of service in the effort to prolong the life of the patient. Thus it would seem to indicate that in certain limited quantities it is a force-producer. But so is strychnine. Probably no drug is more favorably regarded by the modern physician as an efficient heart tonic than strychnine in very small doses. The situation is practically the same with respect to alcohol. In certain very small quantities, and under definite conditions of experiment, it will act for a limited time as a force-producer. Whether this is sufficient to class alcohol as a food is a question that can be best answered when we consider the harmful effects of alcohol, which, we think, more than offset the one reason for regarding it as a food. Alcohol is not economic food, not necessary food, not tissue-forming food; but on the other hand, seems on being decomposed within the body to yield up some energy. But, if in yielding up this energy certain processes are set in motion that cause a cheapening of the individual physically, mentally, or morally, they should be called *unhealthful* foods rather than healthful foods, if the word "food" is to be used at all. Even those who apply to alcohol the term "food," in the technical

sense that it is a force-producer, do not advise its use. Professor Atwater, who has recently demonstrated anew this force-producing quality of alcohol, says: "I myself believe that the more advisable course is habitual abstinence."

Alcohol is Poisonous.—Alcohol tends to destroy tissue, derange bodily functions, and cause the brain to act dishonestly. While technically it may be called a food, practically it is a poison, and there is always danger in its use. Being a dangerous drug, it should only be used when prescribed by a physician. More hard work can be done without alcohol than with it.

Alcohol and Physical Training.—That alcohol is harmful and not beneficial is shown in the very strict rules laid down by athletic trainers. No person, in training for athletic events under the direction of a competent instructor, is permitted to partake of any alcoholic beverage. The trained athlete requires nutritious *foods*, and experience in physical training has shown that alcohol retards rather than assists his muscular development, and interferes with quick and reliable action of the nerves, fibers, and cells.

Physical Effects of Alcohol.—The precise effects of alcohol upon the body have not been fully determined, but enough is known to justify the statement that its effects on the whole are bad. There are certain diseases directly traceable to the use of alcohol. If the individual does not partake of alcohol he escapes these diseases. They include a fatal form of disease of the liver and kidneys, as well as chronic indigestion, disease of the eyes and of the arteries. The best authorities say that there is not a single kind of nervous disease known that cannot be caused by alcoholic excesses.

The Mental Effects.—The fact that the habitual use of alcohol causes so much insanity is an indication of the disturbing effect that it has on the mental processes. Alcohol materially affects the rapidity and accuracy of thought. It makes one inaccurate, incapable of steady application, and tends to make the mind act more slowly. After the so-called stimulating effects of alcohol have passed away, there is always a marked reaction causing mental depression. This paves the way for irritability, which is next door to loss of self-control. The use of alcohol, as will naturally be inferred from our discussion of habit, gradually tends to weaken a person's will.

Alcohol as a Stimulant.—Most authorities admit that for a very brief period alcohol may act as a stimulant, and spur one to greater activity. *Stimulus* means "whip." However, after the burst of energy there is a rebound; the pendulum swings to the other extreme, and there is less than the usual capacity for work. *Does the healthy body need such a whip?*

The Answer.—The use of alcohol in any form is wholly unnecessary for the use of the human body in health. Think of the joy of possessing a good body well built by the use of good food and pure water, and well knit and well proportioned by judicious and regular exercise. Strive to treat your body so that it will be found rich in clean, pure blood; possess nerves that are steady and honest in their action, a brain as clear as a bell, and a mind that is quick and accurate in its operations. To accomplish all these you need no other stimulant than pure air, proper exercise, wholesome food, and the invigorating sunshine. By the use of alcohol, you run the risk of losing one or

more of these priceless qualities so essential to happy, useful lives. The use of alcohol in any form tends to remove one from a position of security to the border-line of danger. He may cross the line without effort on his part, or even in spite of his best effort, and become more of a slave than a master. When once the habit of using alcoholic drinks is formed, and there is an awakening of the individual to his condition, he may battle royally, earnestly, perseveringly, and desperately, but the chances are against his success. It is safe to predict that usually drink will win the struggle, deplorable and unwelcome as such a fact is.

If there is no need of alcohol in any form for the healthy body, then why should any one begin its use when there is so much risk and so much danger involved?

Tobacco Intemperance.—Tobacco is especially injurious to the young. It stunts growth, weakens the nerves, stupefies the brain cells, interferes with digestion, and in many ways counteracts the benefit of good food, besides diminishing the natural appetite. It contains nicotine, and this is a violent poison. Tobacco is a frequent cause of weak eyes, is apt to irritate the linings of the mouth and throat, and in many cases seriously affects the heart.

The effects of tobacco on the individual after he has completed his growth and is over thirty years of age depends on the amount used and on the temperament of the person using it. The tendency, however, is always toward injury. The safe rule is never to use it. Men never express regret for not having formed this needless habit. Tobacco *intemperance* is always injurious to the body at any age. It is an expensive habit,

a man is just as well off without it, and the growing boy always suffers from its use.

Effect of Tobacco on the Young.—From measurements of 187 students of the class of 1891, at Yale University, it was found that the non-smokers gained in weight during the college course 10.4 per cent more than the regular smokers, and 6.6 per cent more than the occasional smokers. In height the non-users of tobacco increased 24 per cent more than the regular users, and 12 per cent more than the occasional. In increase of chest girth the non-users had an advantage of 26.7 per cent and 22 per cent, and an increase of lung capacity of 77.5 per cent and 49 per cent, respectively. These observations with respect to the dwarfing effects of tobacco are borne out by similar ones on the class of 1891, Amherst College, made by Dr. Edward Hitchcock. He found that in weight non-smokers increased during their course 24 per cent more than the smokers; in increase in height they surpassed them 37 per cent; in gain of chest 42 per cent, and in gain of lung capacity 75 per cent. Again, in France, the difference between the students in the polytechnic schools who smoked and those who did not, in scholarship, as shown by their respective class standings, was so great that the government prohibited absolutely the use of tobacco in all government schools.

The employers of labor in many of the large railroad offices and business houses refuse to hire boys who use tobacco. The head of one of the largest wholesale dry goods houses in the world recently stated his reasons as follows:

"The use of tobacco has a peculiarly demoralizing effect on the moral nature of the young. In addition to making

boys tired, stupid, and lazy, it makes them irritable, perverse, careless of the rights and feelings of others, besides, in many instances, leading to lying and even stealing."

Such facts as these certainly indicate very clearly why a boy should not use tobacco in any form.

The Cigarette Evil.—The bad effects of tobacco on the young are even worse when used by them in the form of cigarettes. Most cigarettes are drugged with opium, and the enameled paper is usually made by a process involving the use of poisons. The effect of cigarette smoking on boys is clearly shown in the following quotation from a statement communicated to me by the principal of one of the Chicago schools,* after careful investigation of the influence of this pernicious habit on school work.

"It is only within the last five or six years that the habit of cigarette smoking has made its appearance among the boys of the public schools of Chicago, but during that brief period it has increased to such an extent that several thousand have become addicted to the habit, and the majority of these boys are so affected mentally and physically that they are unable to make further progress in their studies.

"As to my personal knowledge of the effects of this habit on schoolboys. I have carefully observed them for the last three years, during which period at least 125 boys addicted to this habit have been at one time or another under my charge. These boys smoked from *two* to *twenty* cigarettes a day, and not more than ten of them were able to keep pace with their class; yet nine-tenths belong to educated and intelligent fami-

*Mary Darrow Olson, Principal McCosh School, Chicago.

lies. Among these 125 boys were found nearly all of those pupils who were from *two to five years older than the average age of children for the grade,* as well as ninety per cent of those boys hard to discipline, and *all* of those who were in the habit of playing truant.

"An Anti-Tobacco Society was organized, which most of the boys joined. From frank and friendly conversations with them many of their temptations and difficulties were made clear. Twenty-four stated that the reason they failed to learn their lessons was because most of the time they were too sleepy to study; thirty said they were always dizzy after smoking, and did not feel like thinking; twenty-two could not write neatly because their hands trembled; several, to use their own words, felt shaky when they walked. A large number were unable to run any distance, some not more than a block, although before they began to smoke they could run as far and as fast as any one. Nearly all told me they had headaches constantly. With scarcely an exception they stated that they were unable to learn their lessons, though kept night after night for that purpose.

"From 88 schools 2,402 pupils were reported as addicted to the cigarette habit, and only *six per cent* of these were able to do the school work of their grade. As there are 235 schools in Chicago, and as 88 of them report 2,400 cigarette smokers, it is safe, in making a conservative estimate, to say that there are 5,000 cigarette smokers in the Chicago schools. not more than 400 of whom are able to advance with their class."

CHAPTER V.

THE SKIN AND THE KIDNEYS.

We will now talk about the way in which the body gets rid of some of the waste materials. The skin and the kidneys together, acting in much the same way, constitute a very large part of the sewer system of the body. They do much in getting rid of the waste products that would be injurious for the body to retain. Let us first study the structure of the skin.

The Skin.—The skin is the soft, satin-like covering of the body that fits it like a smooth glove or closely fitting garment. It is so elastic that it is never too large or too small. If you take up a little fold of the skin you will notice that it can be stretched like a sheet of india-rubber. Like rubber, when you let go, the skin quickly contracts and appears as before. At the openings of the body, such as the mouth, ears, and eye-sockets, the skin is so closely united with the lining membrane of these cavities, as to be continuous with it. You can hardly tell, as you examine your lips, where the outside skin leaves off and the lining skin begins.

Two Skins.—Perhaps you are not aware that you have two skins, or rather two layers of skin. There is an outer one, called the *scarf skin*, and directly beneath it the *true skin*. The scarf skin, or outer layer, is called the *cuticle* or *epidermis*. The inner layer, or true skin, is called the *dermis*. Did you

ever peel the bark off a young tree, or attempt to make a whistle from a piece of a branch or twig? If so, and you have closely watched, you have noticed that there are really two barks—an outer bark, almost as thin as paper in young trees, but very thick and rough in older ones, and an inner bark that fits tightly against the wood of the tree and its branches. You know that a good deal of the outer bark can be peeled off without doing the tree much harm. If you strip off any of the inner bark you are apt to do the tree much injury, for you thus make the tree bleed by causing its sap to run. Sap is the blood of the tree, and the bark is the skin. If the tree lives, and the bare place heals over, an ugly scar is formed.

The Scarf Skin or Epidermis.—Our bodies are very much like trees, in that they also have two skins. You can run a pin through the thin outer layer, or scarf skin, without causing pain, because it has no blood or nerves. It is this outer skin that puffs up when we have a blister caused by rubbing or burning. This puffed-up blister is filled with a water-like fluid, called serum, from the blood of the true skin or dermis being poured in between the two layers of skin. If you open the blister with a needle, the water runs out. If you now remove the little patch of scarf skin and examine it, you will find that it is very thin and much like the skin that lines the inside of an egg-shell. The outer skin protects the inner skin, and yet it is so thin that the nerves in the latter can feel through it. In some parts of the body, as the palms of the hands and the soles of the feet, it is thicker, because of the greater protection needed at these places by the true skin.

The Pigment.—The under side of the scarf skin is colored by little particles of coloring matter, called *pigment.* In different races this coloring matter differs in kind and amount. In white persons there is very little pigment present, while in albinos there is none at all. In Indians the pigment is of a reddish copper color, while in negroes it is black. In some races the pigment is yellowish, while in others it is brown. *Freckles* are due to the fact that the pigment is not evenly spread out on the under surface of the scarf skin, but is in patches.

The Dermis or True Skin.—The inner skin is filled with blood vessels and nerves. It is more important than the scarf skin. For this reason it is called the true skin. It is thicker than the outer skin, just as the inner bark of a young tree is thicker than the outer bark. It is impossible to prick the inner skin with a needle without causing pain or drops of blood to appear. There are little thread-like muscles within the skin that cause it to contract, giving the appearance of "goose-flesh," or "goose-pimples," when we are suddenly chilled. Some of these muscles are attached to the hairs in such a way that they can make the shorter hairs stand up straight, as is sometimes done when one is badly frightened. You have seen this done in the case of a short-haired dog when he is cross, or the frightened cat he is chasing. In the deeper portions of the skin are two kinds of sacs, or glands—the sweat glands and the oil glands.

The Sweat Glands.—In almost all parts of the skin are to be found tiny tubes with their lower ends coiled and tied into a knot, and their outer ends open on the surface of the scarf

skin, or epidermis. If you look at the palm of your hand you will see not only many coarse lines, but also many fine ridges with little furrows or valleys between them. If you examine each of these little ridges with a magnifying glass, you will see a number of little dark spots arranged along each ridge. Each of these little dark points is the mouth of one of the very small tubes mentioned above. Each of these tubes is called a *sweat duct.* These ducts, or tubes, run down through both the outer and inner layers of the skin, and at the under side you will see the end of the tube rolled up into a coil or ball, as can be noticed by looking at the picture of a highly magnified section of skin on this page. These coiled-up ends of the tubes are called *sweat glands.* It is in these little glands that sweat, or perspiration, is made.

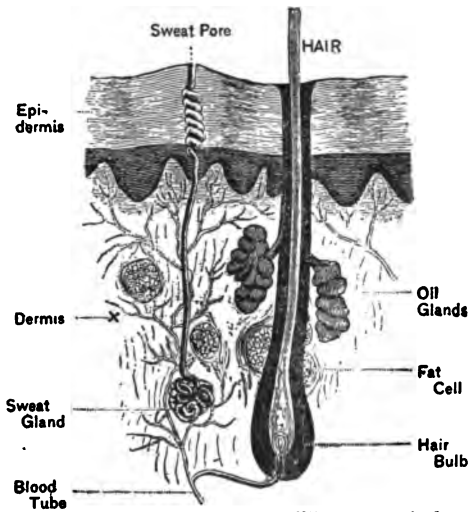


FIGURE 10.—(Modified from Kölliker) A vertical section of the Skin, showing the two layers, the glands, and a hair shaft.

The Perspiration.—Perspiration, or sweat, is being given off all the time, and it usually dries as fast as it forms. If it is warm weather, and we have drunk a good deal of water, or if we have been heated by exercise, we find that the sweat, or

perspiration, is given off in larger amounts, so that it collects in drops that can be seen on the forehead, face, and other portions of the skin. If you wish to see for yourself that perspiration is leaving the skin all the time, you can easily make an experiment that will prove the fact. Take a small, cool piece of ordinary window glass, touch it to the skin and it will soon be clouded over with moisture. A similar experiment is to place your hand inside a glass fruit jar that has been cooled. You will soon see the moisture gather on the sides of the jar. About a quart of perspiration is produced each day, and in a hot day much more.

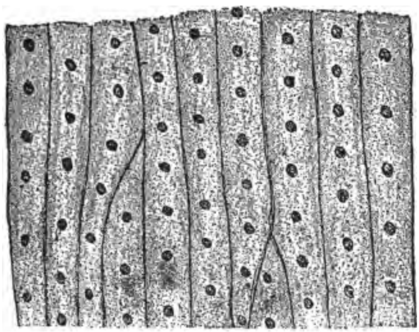


FIGURE 11.—A portion of the Skin from the palm of the hand, highly magnified, showing the openings of the pores.

These pores, or openings of the sweat ducts, are found over the whole surface of the skin. There are nearly three millions of them in all, making from five hundred to two thousand to each square inch, according to the part of the body examined. The total surface of the skin in the grown-up person of average age is seventeen and one-half square feet.

Necessity of Keeping the Pores Open.—If your body were covered over with a paste or varnish, so that all these little pores or openings of the sweat ducts were closed, you would certainly die. An animal covered thus with varnish dies in

about eight hours. Nearly four hundred years ago, one evening at a play in one of the courts of Europe, a boy was covered over with gilt so as to look like a cherub. In a few hours he became very sick, and died before morning, in spite of all the doctors could do for him. He was poisoned because the perspiration was kept in his body instead of being allowed to escape freely as nature demands.

A Cold.—You should never pull off your coat and sit down in a draught of air to cool off quickly. This suddenly checks the perspiration, and the result is what is commonly called a *cold.* A cold is really a form of illness resulting from the sudden closing up of the sweat pores of the skin, thereby preventing the waste matter from flowing out, as it would if the pores were kept open. When we are suffering from a cold we take a glass of hot lemonade or similar hot drink, and cover up warmly in bed to promote perspiration. In this manner, by taking a "sweat," we can quickly cure a cold. To perspire is good; to perspire freely after exercise is also good; but to suddenly check the perspiration by allowing the body to cool rapidly is always harmful.

Oil Glands.—There are also in the skin many little oil glands, that are, as a rule, located near the root of a hair, and they empty their oil into a little sac in which the hair rests. The hair takes up this oil, and it is better for your hair than any oil the barber can use. If the skin is healthy, this natural oil will keep the hair smooth and glossy. A stopped-up oil gland will produce a *pimple;* stoppage of several oil glands at one time will cause a *boil.*

FIGURE 12.—The root of a human Hair beneath the skin, highly magnified, showing the two clusters of oil glands.

Hair.—There are many curious little pockets in the skin, and from each of these pockets grows a hair. In birds these little pockets are larger than in our skin, and from them grow feathers instead of hair. On the head the hair is coarse and long. On the arms and back of the hand it is softer and shorter. A good head of hair keeps one from taking cold. Foot ball players do not usually wear caps while playing the game, but wear their hair unusually long instead. Why is this done?

The average number of hairs on the head is about 120,000. The hair, like the color of the skin, differs with different races. In the Indian it is straight and black. What kind of hair has the negro? The hairs of a white person are not perfectly round, but are oval. The hairs of the Chinese and Japanese are perfectly round.

The hair should be frequently washed, or shampooed, with good soap that is not too strong, and soft water, in order to keep it in good condition. As we grow old, the coloring matter is no longer present in the hair sac, and as a result colorless or gray hair appears. Hair dyes for coloring the hair are poisonous. So are the solutions used to bleach the hair.


FIGURE 13.—A piece of human Hair as it looks under a magnifying glass.

Nails.—The nails of the toes and fingers also grow out of little pockets in the skin, very much as the hairs do. Both hairs and nails are really parts of the outer skin, or epidermis. The nails lie for the most part upon the bare surface of the true skin. The tender true skin lying under the nails is called the "quick." Do you know why?

The nails are made to give firmness and protection to the fingers and toes. The nails of the fingers are of great service in picking up small objects, in untying a small hard knot, and in many other ways, just as the claws of a bird are useful in assisting it to hold to the twig of a tree. For what purpose are the claws useful to a cat? To a dog?

Hang-Nails. Sometimes a little narrow strip of skin near the root of the nail becomes torn up, and hangs by one end. This is called a *hang-nail.* If you have ever had one, you know that they are very sore and painful. But biting them off makes them much worse. They should be snipped off close to the skin with sharp scissors.

The nails should be kept clean. The black-looking dirt under the ends of the nails contains not only much filth, but often little active germs of disease similar to those that we have learned live in impure water. Sickness has been conveyed in this way.

Uses of the Skin.—The skin is very useful in several ways.

1. *The skin protects the body.* The skin is so soft and close fitting, and yet gives so easily with every movement of the arms and legs, that it is a perfect covering for protecting the body.

2. *It removes waste.* The sweat glands are constantly at work removing from the blood some of the worn-out particles of the body which cannot possibly be of further use. These waste particles are carried in the watery perspiration through the sweat ducts to the pores at the surface of the body, where they pass off into the air.

3. *Breathing through the skin.* There are animals that breathe altogether through their skin. A frog can breathe so well through his skin that he will live several days after his lungs have been removed. Some little animals can be killed by means of a drop of camphor on their skins. It smothers them much as water in our lungs would smother us. To some extent we breathe through the skin. We should be very careful that the skin be kept clean and healthy so that it will not by any chance breathe impurities into the blood. Perspiration, when dried and allowed to accumulate on the skin, may be carried back into the system and do much harm.

4. *The skin regulates the temperature of the body.* It is a well-known fact that when water dries up, it cools everything

around it. A hot, dirty street in the summer-time may be thoroughly sprinkled, and in drying again, the air becomes cooler. When the air about us is warm, or we are heated by exercise, the heat of the body is reduced by the extra amount of sweat going to the surface of the skin. When the air is cold there is less perspiration, for there is less demand for the body's being cooled off. The skin with its millions of sweat glands, acts as a self-regulating device for keeping the heat of the body at the proper point.

Bathing.—We have spoken of the necessity of keeping the pores of the skin open. If they were to be closed by means of a paste or varnish, death would result. Now at times patches of varnish do gather on the skin, closing the pores. The sweat, that does such good service to the body in carrying out the waste particles, dries on the skin, and that is why we should bathe at least once or twice a week to keep the skin healthy and the pores open, that the poisonous waste may pass out instead of being kept in the blood. At each bath the skin should be rubbed briskly with a towel, so as to cause a healthy glow. The skin cannot do its work well if the sweat glands are not permitted to fulfill their purpose. A neglect of the skin, by failing to bathe frequently, gives the lungs and kidneys more than their share of the work to do.

Bathing is necessary, then, because three million tiny little sewers or sweat ducts are pouring out filth and dead waste matter on the surface of the skin. The watery portion of this waste dries up, leaving upon the skin thin scales that can scarcely be seen. Water not only cleanses the skin, but stimulates the circulation of the blood.

For the purpose of promoting public health, many of our largest cities have provided free public baths. This is in recognition of the fact that frequent bathing is a good method of preventing disease. That the people who have poor bathing facilities in their own homes are glad to avail themselves of these free public baths is shown by the fact that such a large number take advantage of such an opportunity. In Chicago, as an example, several such free baths are maintained, and recently in a single month eighty thousand persons gladly made use of the privilege.

We should not bathe in water that is too cold or too hot; nor when we are very tired; nor just before or just after a hearty meal. Many people, especially boys, prefer to bathe by going in swimming. This is fine exercise, and an excellent way in which to take a bath, but we should remember that it is dangerous to go in when too warm, too tired, or directly after a meal. Many persons are drowned every year by forgetting these cautions, being taken with cramps while in the water.

A Fair Skin.—Bathing keeps the skin fair and smooth, provided the waste matters in the blood are given off in the proper manner. We should arrange our foods so that there will be the smallest possible amount of waste matter to be given off. You must keep the stomach in good order if you would have a fair skin. If the stomach is loaded down with improper food, irregularly eaten, and too heavy meals that are highly seasoned and spiced, the food will not be digested, and the skin will be of a "muddy" appearance, instead of fair and beautiful.

Face Powder.—Paint and powder are in reality a kind of dirt that clogs up the pores of the skin, and in the end makes the skin look worse than ever. A healthy skin has no more need of face powders than a healthy body has need of the doctor's powders.

Clothing.—For the sake of health, it is important that care be taken as to proper clothing. There is almost as much danger from too much clothing as there is from not enough clothing in cold weather. By overdressing any part of the body, as the throat, for example, more than the proper share of the blood goes to these parts, and they become inflamed. Many sore throats are caused by wearing scarfs and mufflers about the throat. The harm comes from overheating this part of the body, making it "tender," and also from sudden cooling. *Tight clothing* is always injurious. There is no useless space in the human body. The organs within the body need all the room nature has made for them. Tight clothing about the waist crowds the organs whose perfect condition is so necessary to health, and compresses some of them out of place and out of shape. Girls need just as much room for their livers, stomachs, and lungs as do boys. The injury done by tight lacing among American girls is greater, so far as health is concerned, than the injury done to Chinese girls by their fashionable mothers binding their feet so as to deform them into little, rounded stumps. A deformed liver, crowded-up lungs, and a squeezed stomach, are worse for the health than deformed feet. The wearing of flat-heeled shoes, rightly called "common sense," is better for the health than the very high-heeled French shoes, that are sometimes "the style" among some people. Tight

shoes do not permit of proper circulation of the blood, and often cause swellings, corns, bunions, and other deformities and diseases of the feet. The stockings should not be held up by tight elastic garters round the leg, but by supporters, fastened at the waist, or over the shoulders.

If paper was not so easily torn, it would make excellent

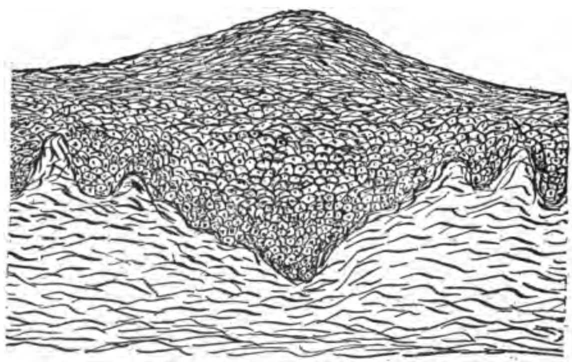


FIGURE 14.—Schematic drawing, representing a Corn, as it appears in section on a microscopic slide.

clothing for cold weather, as it is of such a nature as to keep in the bodily heat. On the coldest nights we can keep very warm in bed by spreading a couple of newspapers over us between the covers.

THE KIDNEYS.

You have already learned of the work of the skin in helping the body to get rid of certain poisons. You will also learn of the work the lungs do along the same line. The kidneys also

assist us in getting rid of many impurities, the retention of which would greatly injure health.

The kidneys are among the most important organs of the body. They are two bean-shaped bodies of the same size, each one being a little larger than half the size of the closed fist, so that in the grown person they weigh five or six ounces. One lies on each side of the backbone, at the back part of the cavity of the abdomen under the lower edge of the lowest ribs. The kidneys in our own bodies are very much like those of the sheep or hog.

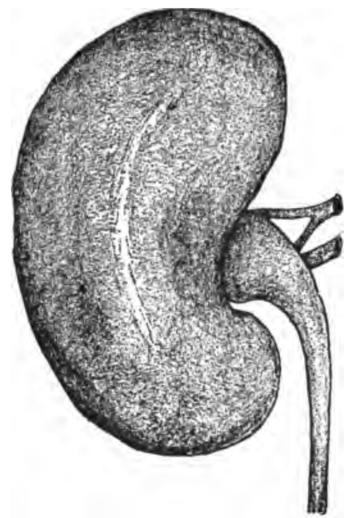


FIGURE 15.—A human Kidney, a little more than one-half natural size in an adult.

The Structure of the Kidneys.—The kidney is full of little tubes or sewer drains, very much like those found in the skin. In fact, the kidneys are not very different from the skin. They are very similar to a roll of skin, turned outside in. The glands in the kidneys, that correspond to the sweat glands in the skin, pour their drainage substance into the cavity within the kidney, shown in the picture of the kidney cut in half.

The Work of the Kidneys.—The general plan of work that the kidneys are called upon to do is quite like that of the skin, though different in some respects, and even more impor-

tant. The kidneys separate poisonous matter from the blood, which, if not removed, would soon cause death. The general name given to the poison is *urea.* The sweat glands help us to rid the blood of some of the urea and mineral matter. Though the kidneys do not get rid of much more water than does the skin, they do rid our bodies of many times more urea and mineral matter. If the kidneys become diseased, they cannot get rid of the urea, and then the whole body becomes poisoned, and *Bright's disease* sets in. This disease is very serious.

FIGURE 16.—A vertical section of a Kidney, showing its pelvis.

Healthy Kidneys.—You can readily guess that the skin and kidneys are in very close relation. Anything that causes the sweat glands of the skin to be inactive, or closes the pores, makes just that much extra work for the kidneys, and as any organ that has to do more than its share of the work is liable to become diseased, the kidneys, from overwork caused by inactivity of the skin, may become seriously diseased.

One way of keeping the kidneys in healthy condition is to keep the skin healthy by proper bathing. In addition we should drink plenty of pure water, not too hard, that is, not containing too much of certain minerals, and we should avoid eating too much rich food, such as pastry. Pepper, mustard and alcohol are especially harmful to the kidneys.

Danger from Colds.—Some diseases of the kidneys are caused by exposure to the cold, especially if the body is perspiring freely at the time. A cold, you recall, checks the activity of the skin by closing its pores; the blood leaves the skin and goes to the internal organs, such as the kidneys, giving them more than their share of the work to do. At the same time a cold, in driving the blood inward, makes the kidneys do double duty in excreting the poisons, and this overwork, together with the extra amount of blood, may cause inflammation of the kidneys.

QUESTIONS FOR STUDY.

1. What are the uses of the skin?
2. What is the structure of the skin?
3. What causes the differences in complexion in different persons? What is an albino?
4. Do you know any animal that sheds its skin every year?
5. What is a cold?
6. Why is it a good thing to take a hot lemonade when one has a cold?
7. How is the temperature of the body regulated by the sweat glands?
8. Why should we bathe?
9. How is chapping of the skin produced, and how may it be prevented?
10. Why should not the nails be cut too close to the flesh?
11. What causes white spots on the nails?
12. Why do scars remain white, even in negros?
13. What are "blackheads"?

CHAPTER VI.

THE BONES.

The main part of a tree you call the trunk, and likewise the main part of your body is called the trunk. The tree trunk has growing out from it branches or limbs; your body has two *arms*, or upper limbs, and two *legs*, or lower limbs. At the top of the trunk is the *head*, or skull, joined to the trunk by the *neck*. The main parts of the trunk are, as you already know, the *chest*, the *abdomen*, and the backbone, or *spinal column*. Each arm is joined to the main part of the body at the *shoulder*, and this joint is called the *shoulder joint*. We have each arm divided into *upper-arm*, *elbow*, *forearm*, *wrist*, and *hand*. The *fingers* are branches or parts of the hand. Each leg has a *hip-joint*, *thigh*, *knee*, *lower leg*, *ankle*, and *foot*. The *toes* are branches or parts of the foot. In this chapter we will consider the bony framework that gives to the body and its parts not only form and strength, but also a means of preserving the shape and solidity of the body.

The Framework of Bones.—If we should attempt to build a house without a good framework of sills, studding, and rafters, it would quickly fall in on itself or collapse. You may have visited a ship-yard and have seen the framework of a big vessel, with its great ribs of oak or steel. The bones are the framework of the body, just as the timbers that are put up in

building a house, or the ribs of a vessel, are its frame. If the body had no bony framework, it would be soft and pulpy like that of an oyster. We would then have to live in a shell, as does the oyster, to keep from being crushed. We would also be unable to run about or do any work.

Inside of the body, under the flesh, is a stiff, strong frame, made up of many bones, closely joined and neatly fitted together. The muscles, which we will soon study, make these bones move, and also make the body plump. We have already learned that the skin covers the muscles as the muscles cover the bones. Sometimes we say a slender person is nothing but "skin and bones." This cannot be true, for if there were no muscles, but simply skin and bones, the person could not move his bony framework. About one-seventh of the body is bone, while a little more than one-half is muscle. There are in each human body 206 bones, and they are very different in size and shape. It would be quite a puzzle to build a toy house of more than two hundred blocks, each one of which had its own proper place, and would not fit anywhere else. You would have to work a long while to put such a block house together.

The Skeleton.—All the bones of the body properly fitted together, each bone in its proper place, make up the skeleton. The smallest are the three little bones of the ear,—the hammer, anvil, and stirrup. The largest bone is the upper bone of the leg—the thigh bone, between the hip and knee.

The skeleton is divided into four main parts; namely, the *skull*, the *trunk*, the *arms*, and the *legs*.

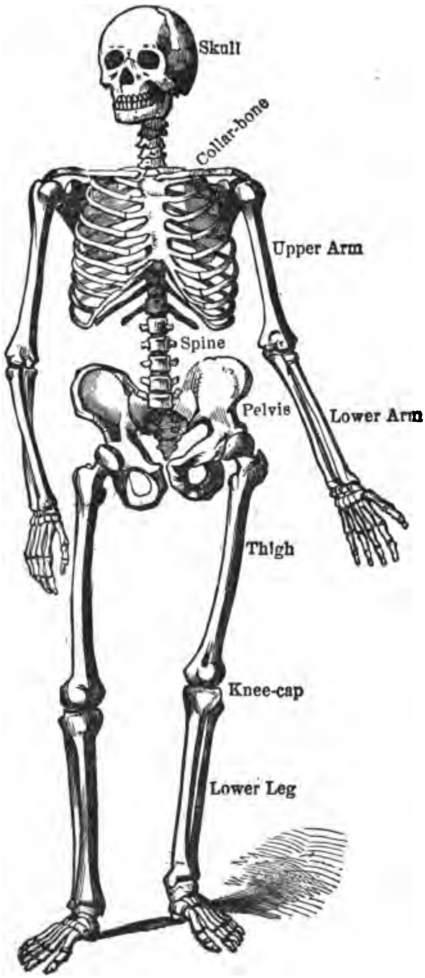


FIGURE 17.—Skeleton of a Man.

Shape of the Bones.— The bones in the different parts of the body are very different in shape. We have flat, curved plates, or shell-shaped bones to form the skull. Round bones, like pebbles, are found in the wrists and ankles; while little, slender bones form the fingers and toes. The backbone is made up of a large number of rings of bone. In the arms and legs we have long bones. Each of these long bones is really a hollow tube with a very hard outside. The inside is filled with a soft fat, called *marrow*. Such a bone is called a marrow-bone. You know the frame of a bicycle is made of hollow tubing. This gives strength and lightness much the same as in the long bones of the body.

Strength of Bones.—Each bone is hard and very strong. The bones are so made as to bend, as would a tough stick of wood of the same size, before breaking. A good, healthy bone is twice as strong as an oak stick of the same size.

The Skull.—The skull is made up of a number of plates of bone, so put together as to form a hollow, bony box, which holds the soft, delicate brain, and at the same time protects it. There are eight of these plate-like bones forming the brain box; there are three little bones in each ear, and fourteen bones in the face. This makes in all twenty-eight bones of the head.

The Trunk.—The bones of the trunk are the *ribs* (twenty-four bones), the *breast-bone* (one bone), the *pelvis* (two bones), and *backbone* (twenty-six bones). They form a framework that protects and contains the vital organs, such as heart, lungs, liver, stomach, kidneys, and intestines. The *tongue-bone* (one bone) is included in the bones of the trunk, making fifty-four bones.

FIGURE 18.—The Thigh-Bone.

The backbone, or spinal column, runs the entire length of the back, and instead of being but one bone, is made up of twenty-six separate rings of bone. Be-

tween the rings of bone are thick pads of gristle, which act as springs or cushions, and keep the body from being jolted when we walk, run, or jump.

The ribs extend from the side of the backbone around the sides toward the front of the body, where they are joined by the gristle or cartilage of the flat breast-bone. The ribs look a little like the hoops of a barrel. With the backbone and breast-bone they form a box-like cage called the *chest*, which contains, and at the same time protects, the heart and lungs.

The Arms.—Each of the arms, above the wrist-joint, has five bones. They are the *collar-bone*, which joins the shoulder to the breast-bone; the *shoulder-blade*, at the back of the shoulder; the *upper arm-bone* between the shoulder and the elbow, and the *lower arm-bones* between the elbow and wrist. There are eight little bones in the wrist, five bones in the body or palm of the hand next to the wrist, and fourteen bones in the fingers. This makes thirty-two bones in each arm, or sixty-four bones in both of the upper limbs.

The Legs.—The bones of each leg are the *thigh-bone* (called the femur), extending from the hip-joint to the knee, the *knee-cap*, the two *lower leg-bones*, the *heel-bone*, six other little bones in the ankle, five bones in the *instep* (the part of the foot next below the ankle joint), and fourteen bones in the toes. This makes in all thirty bones in each of the lower limbs, or sixty bones in all. We have, then, in the

Skull and face - - - - - -	28 bones.
Trunk - - - - - -	54 bones.
Arms - - - - - - -	64 bones.
Legs, - - - - - -	60 bones.

A total of 206 bones in the human body.

Comparison of the Hand and Foot.—In many respects the hand and foot are very much alike. The toes are shorter than the fingers, and are not so movable. You cannot move the big toe as you can your thumb. The instep is much stronger than the wrist, because it must do heavier work. It must not only be strong enough to hold up the weight of the body, but in addition must bear the weight of any load we carry. On the

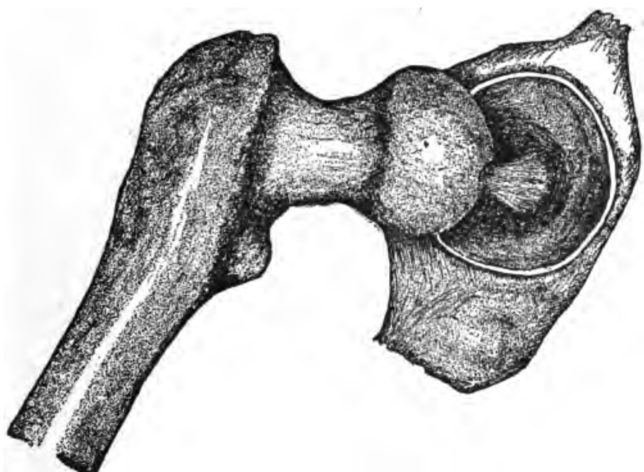


FIGURE 16.—Mechanism of the Hip-Joint.

whole, the foot would make a very clumsy hand, and yet we know of people without arms that can use their feet quite well to do the work usually done by the hands. An "armless wonder" may so educate and train his toes to do the work of the fingers as to be able to hold a pen and write quite well, or even hold a brush and paint pictures with them.

The Joints.—The places at which two or more bones are fastened together are called joints. Some joints move quite freely, as the *ball-and-socket joint* of the shoulder or hip, or the *hinge-joint* of the elbow, knee, or finger. Others have no motion, as the bones of the skull. Hinge-joints can open and shut in one direction only, like the blade of a penknife. If the arm or leg is straight at the elbow or knee, and should be bent in the wrong direction, the bones are either broken or put out of joint. In a ball-and-socket joint, as that of the hip or shoulder, the end of the long bone is rounded like a half of a ball. This rounded end fits into a cup, or socket, in the other bone, making it possible for the arm or leg to be moved and turned in any direction.

Cartilage.—The ends of the bones which rub together at a joint are protected by a smooth, tough covering which acts as a cushion and keeps the ends of the bones from wearing. The tough cushion is made of gristle and is called *cartilage.* You have seen this at the end of one of the bones in a joint of beef, or "soup-bone."

The inside of the cup, or socket, is lined with a little fine skin, or membrane, made into a bag which is filled with a fluid like the white of a raw egg. This liquid oils the joints, keeping them from becoming dry. Just as we oil a rusty hinge to keep it from squeaking, or oil the joint where the blade is attached to the handle of a knife to make it open and shut easily, so nature provides for the oiling of the movable joints of the body. If the joints were dry, every movement of the body would become not only difficult, but very painful.

The joints are held together by means of stout bands of muscle, called *ligaments.*

The Periosteum.—Live bone is covered smoothly over with a tight, tough, strong, thin membrane. This cover extends over the whole surface of the bone, except at the joints, where the cartilage takes its place. This membrane, or thin, skin-like covering of the bones, is called the *periosteum.* It is very important for two reasons: first, the muscles grow fast to the periosteum much more easily than they would to dry bone; second, if a portion of the diseased bone is removed, as in the case of the femur, or thigh-bone, and the periosteum is not injured, new bones will form in the place of the decayed bone that has been removed. If, however, the periosteum itself is removed or injured, the bone substance dies, and new bone is not formed. The periosteum is full of blood vessels, and in this way the bone receives the nourishment needed for health and growth.

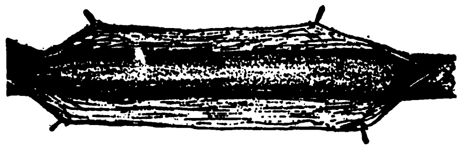


FIGURE 20.—A section of Bone, showing periosteum, partially removed.

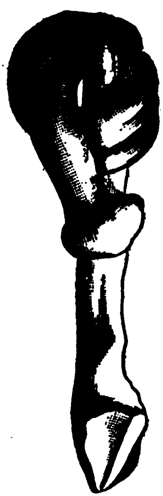


FIGURE 21.—Bone tied in a knot after mineral substances are removed by action of acid.

Of What are the Bones Composed?—The bones contain mineral matter, such as chalk and lime, and animal matter to make them tough and keep them from crumbling. The

mineral matter keeps the bones from bending too easily, and consists chiefly of lime. This can be dissolved out of the bone by soaking it in weak acid. The bone will then keep its size and shape, but will be very easily bent like a rubber tube. When the mineral matter is out of the bone, it is so easily bent that we can tie it in a knot, as you see in the picture. The bones of young people contain a larger proportion of animal matter than the bones of older persons, and are more easily bent. This is the reason little children often become bow-legged. In walking at too early an age, the weight of the body causes the bones of the legs to bend.

FIGURE 22.—Foot of Chinese Woman.

If we burn a bone, it becomes much lighter and much more brittle. By burning a bone we take out the animal matter and leave only the mineral lime and chalk which will not burn. The mineral matter is needed to keep the bones stiff and firm, while the animal matter is required to make them tough and keep them from breaking easily.

You remember that our food must contain some mineral matter to keep the bones in healthy, firm condition, and prevent them from becoming soft and gristly. Like the tender, green twigs of a tree, the soft bones of a young child bend very easily. We all know that the branch of a tree not only may be very easily bent, but may be kept bent for a time, and will grow hard and firm in this position, always remaining bent and

deformed. Likewise, the body of a child may be deformed. In China it is the fashion for rich ladies to have small feet, so when they are children the bones of their feet are bound and pressed together. This deforms the foot both in size and shape. Tight, pointed shoes make our toes grow out of shape by cramping them and twisting them to one side. A high-heeled shoe deforms the instep.

Improper Positions.—When we are young our bones are so soft and so easily bent that they very readily grow out of shape if we allow ourselves to make use of improper positions in sitting, standing, walking, or lying down. In this way we may grow to be flat-chested, round-shouldered, with badly curved backbones, and have a number of other deformities. By sitting, standing, or walking erect we may make our backs straight, our shoulders even, and our chests full. A soldier is straight because he has been compelled in drilling to keep his back straight, his shoulders even, and his chest out.

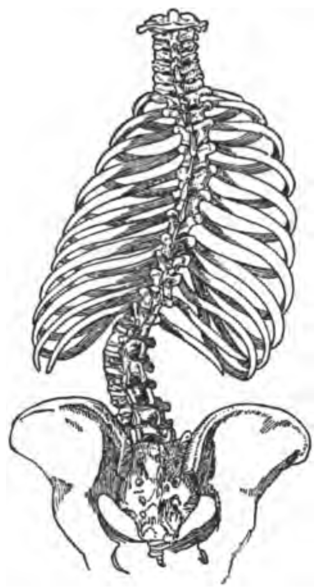


FIGURE 23.—Showing curvature of the spine, caused by sitting in improper positions.

Many boys and girls have misshapen and deformed bodies because they have not had school seats and desks to fit them. We must sit, stand, and walk with our shoulders well back and

FIGURE 24.—Improper position, because of too high a desk.

our chests well out, so as to have well-formed bodies. A school seat or desk, too high or too low, will cause ugly curves in the backbone, and thus deform the body.

School Seats and Desks.—The seats and desks should be so made as to be raised or lowered according to the height of the boy or girl using them. The seats should be low enough to permit the feet to rest upon the floor. If the school seat cannot be lowered so that the feet can touch the floor, a board plank or a couple of bricks should be placed on the floor so that the feet will not have to hang without any support. If the feet are not resting on the floor or some support, the legs become very tired, and in addition, deformity and injury of the body are caused. Older people do not seem to know that the legs of little children become tired, in church and other places where the seats are too high for the feet to touch the floor, much more quickly than do the legs of grown-up people.

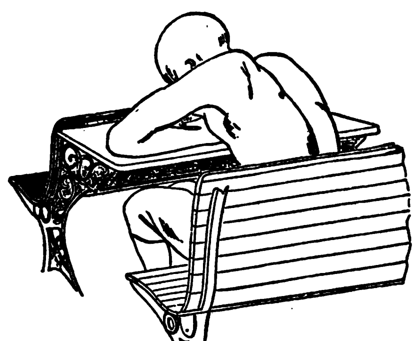


FIGURE 25.—Incorrect position, due to seat and desk being too low.

Neither should the seat

be too low. It is just as harmful for a large, long-legged boy to sit in a seat too low, as it is for a smaller boy to sit in a seat too high from the floor. The boy with long legs will have to bend them up or twist them about the seat so that they do not grow straight, and do not help to support the weight of the body in sitting. Besides, his position will be very uncomfortable, and he cannot do as good school-work as if he were more comfortably seated. We cannot do our best studying when we are tired, and we can by no means do the good work of which we are capable if we are compelled, by the size or shape of the seat, to sit in an uncomfortable position. But most serious of all is the danger of deformity that will result from continued use of an ill-fitting seat and desk.

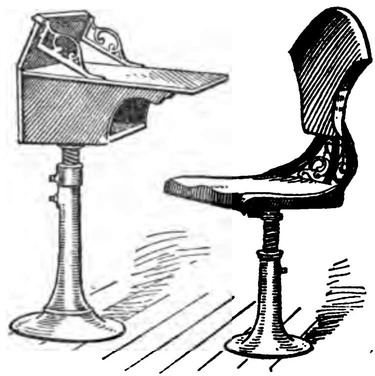


FIGURE 26.—An adjustable seat and desk. (See foot-note.)

Adjustable Seats.—In order to make it possible for school seats and desks to be of the proper height, they are now being made so that they may be raised or lowered. Such a desk or seat is called *adjustable*, because its height can be readily changed. There are many such seats and desks now being used. The one here pictured* is raised and lowered in the same manner as is a revolving office chair.

* From "Hygienic Desks for School Children," by Dr. Mosher, in Educational Review, June, 1899.

Growing Out of Shape.—By standing habitually on one foot, sitting bent forward for any considerable length of time while reading or studying, sleeping with head raised too high on a very thick pillow, walking in a slipshod, careless manner, we are placing ourselves in great danger of having our bodies grow out of shape. While we are young the framework of our bodies is growing, and our bones very easily take the shape we give them. To give them the right form we must fix firmly the habit of holding the body erect. In holding the shoulders back, we make the chest stand out full, giving more room for the heart and lungs, and we can in this way breathe more air and have better blood, and at the same time make the forms of our bodies more and more as they should be.

FIGURE 27.—The same seat and desk as used in writing.

Broken Bones.—Sometimes by rough play, a fall, or other accident, the bones may be broken in two, just as a stick may be broken. At the broken place the ends are splintered much as in the case of a broken stick. The bone should be set in proper shape as soon as possible after the injury, and the parts held firmly together in the same position by means of a thin piece of board, or shingle, called a "splint." Sometimes it is necessary to use a plaster-of-paris cast in bandaging the broken member, in order to hold the broken parts together

securely. After being placed together right, Mother Nature does the rest of the work. The broken ends are quickly surrounded with a jelly-like substance from the blood. This grows harder each day by taking into itself mineral matter from the the blood, until at the end of a few weeks hard bone is formed, firmly binding the broken and splintered ends together. Sometimes the portion thus mended becomes even stronger than the original bone.


FIGURE 28.—The same seat and desk as used in study.

Sprains.—Sometimes the little muscle bands, or ligaments, that hold the bones together at a joint, are overstretched or even torn by sudden twisting or turning. A finger or thumb may be sprained by being bent too far back, and an ankle by being turned suddenly to one side. A sprain is a very serious accident. Sometimes a sprain is even more serious than a broken bone. There should be complete rest of the part sprained until it can be used without pain. If the ligaments are torn so badly that the ends of the bones are out of place at the joint, we have a *dislocation*, or bones out of joint. This is always a serious accident. In pulling at your fingers to make them "crack" at the knuckles, you are weakening these joints, and at the same time causing the knuckles to grow into large lumpy knots.

CHAPTER VII.

THE MUSCLES.

You know the bones are covered over with a soft substance which we call flesh. We eat the flesh of animals, and as you look at a beefsteak you will discover that some of the flesh is white or yellowish, while the rest of it is red. The white or yellow flesh of a piece of beef is fat. The red, lean flesh is composed of *muscles.*

The bony framework of the body is covered over with muscles, and they form a little more than half of its entire weight. As the brain does the mental work, so the muscles do the physical work. Of course you are aware that the arms and legs, the fingers and toes, the mouth and tongue, the eyes and heart, are all moved by means of muscles. Bend the arm at the elbow so as to bring the hand to the shoulder as strongly and as far as possible, and you will notice the muscle of the upper arm bunch up under the skin. You can both see and feel it. If you are right-handed, and therefore use the muscle of the right arm more than you do that of the left, the muscle of the right arm is larger. Look at the back of the hand as you move your fingers, and you can see the action of the cords that run from your arm to the finger ends. Clasp the left hand tightly round the right arm just below the elbow, and you can readily discover the action of the muscles of the arm

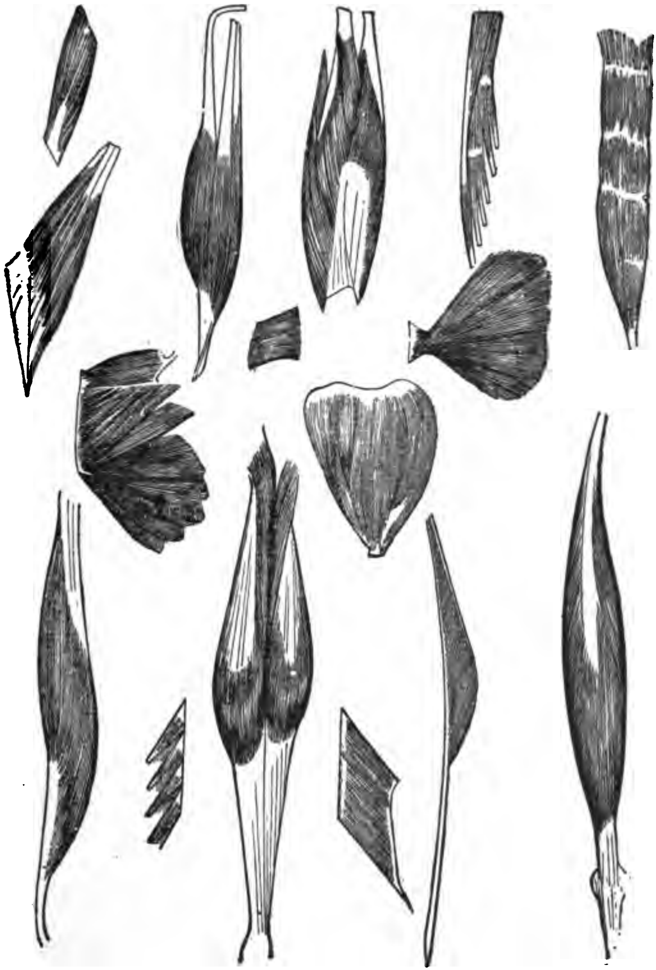


FIGURE 29.—Showing some of the Muscles of the Human Body. Observe the marked differences in shape.

that have so much to do with the movements of the fingers. Place the tips of the fingers at the side of the face, just in front of the hinge of the lower jaw; now shut the teeth firmly and note the bulging of muscle.

Number and Shape of Muscles.—You have about five hundred different muscles in the body. They are arranged in such a way as to give the body a rounded and beautiful appearance, and at the same time to do the best work in moving the body and its parts in the easiest and most useful fashion.

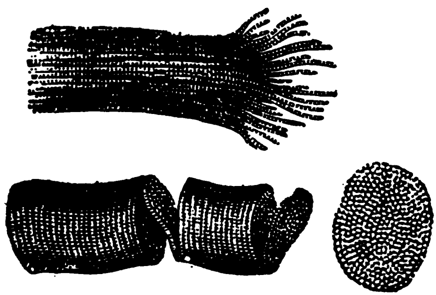


FIGURE 30.—Showing the Structure of Muscles.

The muscles are of many different shapes and of various sizes. The largest muscle of the back, the chief one used when we raise the body from the ground by means of the arms, weighs several pounds. One of the muscles of the legs, the one used when we cross the legs "tailor fashion," is two feet long. One of the muscles inside the ear, the stirrup muscle, is but one-sixth of an inch long and weighs only one grain. Many of the muscles are arranged in pairs so that we have two alike both as to size and shape—one for each side of the body.

Structure of the Muscles.—If you look at a piece of corned beef that has been well boiled, or a slice of chipped dried beef, you will discover it seems to be made of bundles of small fibers or threads of flesh. With a sharp needle or pointed knife-

blade you can pick one of these small fibers into smaller and finer threads. Looked at under the microscope, it is found that any one of these is made up of still finer fibers, finer than the finest silk thread, even much finer than the finest thread of a spider's web. Each one of these very fine threads of flesh is called a *muscular fiber*. Many of them bound together into a single bundle make a muscle.

FIGURE 31.—Showing how the muscles shorten and thicken, when bending the arm.

How the Muscles Act.— When we make a muscle act, each of its tiny little threads makes itself shorter and thicker, just as a stretched rubber thread becomes thicker if we

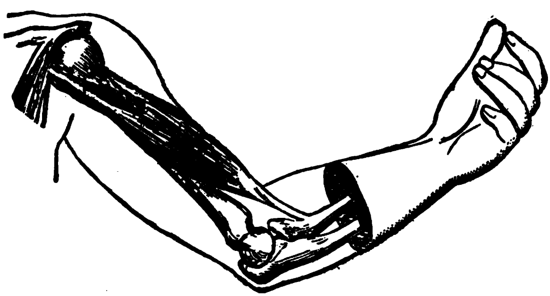


FIGURE 32.—Showing how the muscle appears when arm is extended.

let go of one end and permit it to go back to its original size and shape. Measure with a tape the circumference of the

upper arm when the arm hangs down free; measure it again when the arm is bent with the hand to the shoulder. In the same manner measure the forearm a short distance below the elbow when the hand is open, and again when the hand is tightly clenched. By such experiments as these we learn that when a muscle works it becomes shorter, thicker, and harder.

Muscle does its work by shortening. In shortening it pulls on the bones and produces motion. When a muscle shortens it is said to "contract," but inasmuch as it occupies the same amount of space all the time, the word "contract" is scarcely correct; for when muscle shortens it does not get smaller, but thickens in proportion, and thus fills the same amount of space it did before.

A muscle cannot be kept shortened any great length of time. If you hold your arm out straight as long as you can possibly do so, it at first feels tired, then finally it pains. The muscles are so related to each other as to have periods of action and then periods of rest. In many of our bodily activities, such as walking, one set of muscles acts while the other set rests, or gets ready to act again. This is the reason that it is not so tiresome to walk one hour as it would be to stand perfectly still for a much shorter time. One muscle (biceps) bends the arm at the elbow; another muscle (triceps) unbends or straightens the arm. When one of these muscles is shortened, the other is lengthened. In order to be ready for action, the muscles are always slightly stretched. This is the reason, when a cut is made into the flesh, the wound always gapes open.

Muscle Fastenings.—Most of the muscles are made fast to the bones, and, as a rule, one end of the muscle is attached to

one bone and the other to another bone. Sometimes one end is fastened to a bone, and the other end attached to the skin or other muscles. There are some muscles that are not attached directly to the bones, but are made fast by means of hard, firm cords called *tendons.* You can feel tendons by placing the thumb of one hand upon the wrist of the other hand, then by working the fingers of the latter hand, you will quickly discover these small, hard cords moving under the skin. The tendon just above the heel supports the weight of the body when we stand on tiptoe. It is the largest tendon in the body, and is called the *tendon of Achilles.* Your teacher will tell you how it got its name.

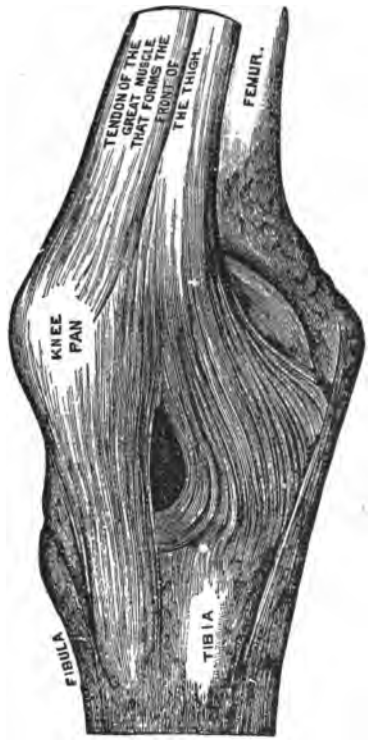


FIGURE 33.—Knee-Joint, showing tendons.

Motion.—Motion is the most prominent sign of life. If an animal shows no movements whatever, it is no longer alive. We move to get our food; and we move when we eat and digest it. We move to avoid injury, as when we dodge. Even during sleep the movements of breathing are seen. Place your

hand on the left side of your chest, and you feel your heart beat. Your finger placed at the wrist can feel the beating pulse. To properly taste food, we move the tongue about; to see, we open our eyelids and turn the face toward the object; to smell, we sniff with our nostrils; to hear, we turn the head; and there is motion within the ear so as to adjust its various parts that we may hear correctly; to feel, we move the hand or finger to touch the object. There is motion when we speak, when we write, when we laugh, when we sing, and there is motion in the expression of the face. Motions are necessary to every process of life, and all motions are produced by the muscles. How important, then, the muscles are! How necessary that we keep them healthy by the proper food and exercise!

How to Make the Muscles Strong.—If we rightly use our muscles, they will surely become strong. As a rule, the muscles we use the most are the strongest, unless they have been so overworked that they give out. The arm we use the more is stronger than the other arm. The arms of the blacksmith, boilermaker, or carpenter are much stronger than the arms of persons who do not exercise them. The calf of the leg of a soldier on the march, or of a letter-carrier who must walk a great deal, develops into a great bunch of hard muscle because of much use. Men who work out of doors at healthful labor are much stronger than tailors or clerks, who use only a few of their muscles, and are confined by their work indoors. Boys and girls who live where they can play and work out of doors are very fortunate. They will become much stronger and be more healthy than the boy or girl shut up in the dingy rooms of a tenement house in one of our crowded cities.

FIGURE 34.—Muscles of the Back.

Children of the very rich who are not so fortunate as to have some regular work to do that would give their muscles exercise, and who, instead of walking, running, skating, or romping with other children, ride about in a carriage, and are treated much as delicate flowers in a hot-house, are also to be greatly pitied. They are often saved from the work that would do them much good, and develop their growing muscles, by servants and others who are employed to do their work for them. It may be very nice to have fine clothes of delicate colors, but I am sure every boy and girl will agree with me that it is a great deal better to have clothes that permit us to exercise all we wish without soiling or tearing them. Little Lord Fauntleroy, with his close-fitting velvet suit, fine slippers, and long, carefully arranged curls, may be the kind of a boy for a picture, but the boy who is healthy and happy is the one with strong, loose clothes that have big pockets bulging out with string, nails, marbles, and other of his treasures, who can thus use his muscles freely as he does his work or plays games.

Necessity for Exercise.—The muscles get food, nourishment, and strength from the blood. Exercise causes more blood to flow to the muscles, and in this way exercise brings more food to the muscles, making them develop. It is a well-known fact that the time to develop, train, and educate any muscle is at the time of its most rapid growth. The proper time to develop, train, and educate the muscles of the arm is when they are growing most rapidly. After the muscles have acquired their growth they cannot be benefited so much by exercise as they would, could they have been intelligently and extensively used earlier. Exercise while we are young does

much more good than it will when we are older. As we become older, our muscles become more fixed in form and size, and exercise of them does not accomplish what it would have when they were younger and more plastic. We will speak of the best kinds of exercise for boys and girls in a separate chapter. You will then learn what exercises are helpful in the growth and development of the muscles, and what exercises are harmful.

FIGURE 35.—Muscles of the Face and Neck.

Necessity for Rest.—To use the same set of muscles very long not only renders them very tired, but very weak. After our muscles have been properly exercised they should be rested. To become too tired is not only very painful but very injurious. It has been proven that great fatigue actually poisons the blood. If we inject some of the blood of a very tired animal into a healthy rabbit, it will die because of the poison of fatigue in the blood of the tired animal. Exercise is good, if it is of the proper kind and amount, but overwork and overstrain of the muscles are always injurious. Some children do not grow to

their full size or strength, because when yet young and growing fast, at the age of from ten to fourteen, they quit school and go to work at some employment too heavy for them, either in store, factory, mill, or mine, and by overworking their muscles become very tired, thus stunting their growth and preventing their reaching the full development necessary to healthy, happy lives. Muscles used until they are strained become weaker instead of stronger, for they will wear out faster than they can be fed by the blood.

Round Shoulders.—Curvature of the spine and round shoulders are generally the result of improper positions. A person becomes round or "stooped" shouldered by standing or sitting in an improper position until the backbone, or spinal column, loses its right shape. Sitting at a desk too high or too low injures the muscles as much as it does the bony framework, which, as you recall, was discussed in the last chapter. The muscles of our backs, if they are properly used, hold us up, throw our shoulders back and keep us in an erect position. A lazy person will let his shoulders stoop, and hold himself up by leaning against a table, desk, or the wall while standing. Sometimes such a person will wear shoulder-braces to keep the shoulders in their proper position. These braces usually do harm because they rest the muscles and prevent them from doing the work they should, thus allowing them to become weak. Soldiers have a better way. They make the muscles hold the shoulders back by their constant drill in the line, and standing and walking in an erect position. It is easy to get these muscles so well developed by military drill that it will be perfectly natural for us to sit and stand erect, and be painful

for us to let our shoulders become stooped and round as the body lops forward, even for a few minutes. Military drill is a very good thing for schoolboys, whether they receive it in a gymnasium, or get it by organizing a military company of their own. It would be a good thing if in every school there was such a military company formed and a short drill had every day. Round shoulders, then, come from careless habits of sitting and standing, or from improper seats and desks in the schools. Such a position as we have in stooped shoulders narrows the chest, makes it of less capacity, and weakens the lungs, thus in a measure causing injury to the health. The reason that the peasant women of Europe, who work so hard, have such straight, erect bodies, is that they are often compelled to carry heavy burdens on their heads. These heavy loads cannot be carried on the head unless one walks erect and steady, so these women come to have straight backs. Careless habits in sitting not only do much harm, but are very difficult to correct, and if not corrected in our youth, the muscles become so fixed and "set" that such habits are not overcome in later life.

Effects of Inactivity.—We know, then, that in order to make the muscles strong, they must be used. To make the whole body strong, every group of the five hundred muscles in the body must be exercised. If your arm should be tied in a sling and kept there, and you should, as a result, use only the other arm, the idle arm would become small, puny, sickly, and weak, while the used arm would continue to develop and grow large and strong. Any part of the body, any set of muscles which is not used, will surely become weak in the course of time. We should, therefore, take a certain amount of exercise

or muscle activity each day, just as we necessarily take a certain amount of wholesome food and drink each day. Both are equally important to life and health.

Self-Acting Muscles.—There are some muscles in the body that do not act simply when we wish them to do so, but they act when it is necessary, whether we wish them to or not. The muscles which cause the heart to beat, or cause us to sneeze or hiccough, are of this class. Did you ever try to stop sneezing or hiccoughing? If you have, you have discovered that though you tried very hard you could not succeed in your effort. The muscles which act of themselves are called *involuntary muscles.* The muscles that move the arm, hand, or tongue, act when we wish them to do so. They receive their orders from the will, and act accordingly. Such muscles are called *voluntary muscles.* If the muscles of the arm were of the self-acting kind, we could not direct its movements. If the muscles of the heart had to be directed by us, and were not self-acting, we would have to stay awake all the time to keep the heart beating and its muscles going. Do you not think it a very good arrangement to have some of the muscles of the body self-acting or involuntary?

Effect of Alcoholic Drinks upon the Muscles.—Alcoholic drinks never do any good to the muscular system, and often do great harm. Continued use of alcohol as a beverage causes lasting changes for the worse in muscle structure. The fat cells become too abundant and take the place of proper muscular tissue. Indulgence in alcoholic drinks frequently causes enfeebled heart action and "fatty degeneration" of the heart. Alcohol diminishes the power of endurance. Men endure more cold and more hard work without alcohol than with it.

CHAPTER VIII.

THE BLOOD AND ITS CIRCULATION.

You have already learned that all parts of the body derive their food and nourishment from the blood. Each part selects from the blood just the food it needs. The solid food we eat is dissolved, as you remember, by the process of digestion, and is then taken up by the blood and carried to every portion of the body.

Every living plant or animal of the higher sort secures its food by means of a fluid circulating through it. In plants this fluid is the sap; in insects, a colorless, watery blood; in fish, a red but cold blood; in man, red, warm blood. On account of its necessity to life it is often called the "river of life," and sometimes the "vital fluid."

The Blood.—One-twelfth of the weight of your body is blood. When you weigh one hundred and twenty pounds, your body contains about ten pounds, or nearly two and one-half gallons of blood.

You have perhaps seen a microscope, and know that it is an instrument which, when we look through it, makes objects appear many times larger than they really are. Looked at through the microscope, the foot of a fly appears as large as your hand. When we look at a drop of clear but impure water through a microscope, we see that it is full of living little animals that

cannot be seen by the naked eye. Now, if you place a single drop of blood under the lens of the microscope, and look at it, you will discover that the color of the blood is caused by little, flat, round particles, so small that it takes three thousand of them, placed side by side, to measure an inch. These discs are called *corpuscles.* While the blood appears, to the unaided eye, like any red fluid, such as dark red ink, the microscope plainly shows that there are two parts to the blood, a colorless, watery fluid, called *plasma,* and the tiny bodies called corpuscles.

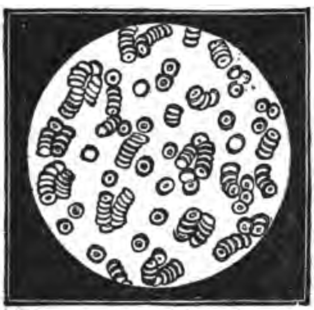


FIGURE 36.—The Corpuscles of the Blood.

The Corpuscles of the Blood.—Most of the corpuscles are red, and they give to the blood its color. A few of them are white. The red ones are more important as well as many times more numerous, for they act as food carriers to all parts of the body. In the healthy person there are three hundred red corpuscles to every white one. These little red bodies go floating through the veins and arteries like little rubber boats, for they sometimes stretch out long and thin, in order to get through the narrow channels, valves, and gateways in the small blood tubes. In a drop of blood there may be found from three to five millions.

The Use of the Corpuscles.—The red corpuscles, which we have compared to little rubber boats floating in the waters of the blood, have a very important work to do. They go to the

lungs which are filled with the fresh air just breathed in, and they come close to the air in the lungs and take from it as big a load of oxygen as they can carry. Oxygen is a gas contained in the air, and is one of the many things that strengthens, refreshes, and repairs the body. These little red corpuscle boats float down from the lungs through the limbs to the very tips of the fingers and ends of the toes, through the finest little hair-like blood canals, and to the finely woven web of blood vessels on the surface of the brain, carrying oxygen to the nerves, muscles, and other tissues of the body. Just as soon as they give up their oxygen, these same corpuscles hasten back through the veins to the heart, and then again to the lungs for another load of life-giving oxygen gas. Because of the special work they perform, the red corpuscles are called oxygen carriers. The white corpuscles have work to do in keeping the body in good repair, and seem to stop at any portion of the body where, on account of disease or injury, there is any mending to do. They also destroy poisons.

While no part of the body could live without the blood to nourish it in the manner we have described, we must not forget that the blood also renders another great service by gathering up the waste and poisonous materials and carrying them on to be cast out of the body. No part could live if these waste impurities were not carried away. Not only is the blood the feeder, but it is also the sweeper and cleaner of the body.

Circulation of the Blood.—Because the blood goes round and round in your body from the head to the lungs and back again, then to the hands, feet, and heart, and then back again to the heart, in something of a circle, it is said to *circulate.* The

tubes through which the blood is carried to and from various parts of the body, are called blood vessels. There are three kinds of these blood tubes or blood vessels. One set carries the blood out from the heart to the remote parts of the body; these are the *arteries.* Through another set of blood vessels the blood flows back to the heart; these are called the *veins.* The arteries and veins are blood vessels through which the blood is carried, but the blood stream of one flows in an opposite direction to that of the other. At various points in the body, more especially at the places farthest away from the heart, are little hair-like canals, or tubes, arranged in a sort of network. They connect the arteries and veins. These little blood vessels form the third set and are called *capillaries.*

FIGURE 37.—Large Arteries of the Leg.

The Arteries.—The arteries or blood tubes that carry the blood from the heart to the various parts of the body, have strong, tight, and tough sides, or walls, so that they cannot easily leak or burst. These walls of the arteries contain many little muscles that make them larger or smaller, as the case may be, according to the amount of blood required to be conveyed to the different parts of the body.

Capillaries.—While the arteries are quite large near the heart, they divide and subdivide as they leave the heart, and go toward the extremities, until they have separated into a large number of very fine tubes called capillaries. The network of the capillaries is so fine and delicate that they touch every cell of the living body. You cannot prick through the skin with a needle, or cut your finger even very slightly, without tearing the walls of some of these little capillaries and causing the blood to appear on the skin. The walls of the capillaries are not so tough, thick, and tight as those of the arteries. Indeed they are very thin, so that the fluid part of the blood, the plasma, containing food, can soak or seep through to every little particle of nerve, muscle, and bone near them. Even some of the white corpuscles are able to squeeze their way through the side walls of the capillaries to places where they are needed to do the repair work. The tubes are as small as the finest hairs, and the red corpuscles can just squeeze their way through toward the ends of the veins.

FIGURE 38.—Veins of the Leg.

The Veins.—The capillaries again come together and form larger tubes, called veins. The veins increase in size the nearer

they are to the heart. They carry the blood from the various parts of the body to the heart. The blood in the veins contains much waste matter and poisonous impurities thrown off by the bodily tissues through which it flows. The veins are all provided with little gates, or valves, that open only in one direction. These little valves are so arranged that they will permit the impure blood to flow only toward the heart (see Fig. 39), and will not let any of this poison-laden blood get back to the cells of the body, which the blood, when pure in the arteries, fed, swept, and cleaned. Every vein is found close to the artery which brought the blood to it. The blood is kept constantly moving in the tubes, but only in one direction—from the heart, through the arteries, and through the finely branched network of the capillaries. These then merge into tiny veins, which unite to form larger veins, through which the blood continues its journey back to the heart. The various parts of the body receive a supply of blood in proportion to their size and the extent to which they are used. Thus, the brain weighs but one-forty-fifth as much as the rest of the body, but uses one-eighth of all the blood supply. A piece of bone weighing as much as the brain would receive very little blood in comparison, because bone is quite inactive.

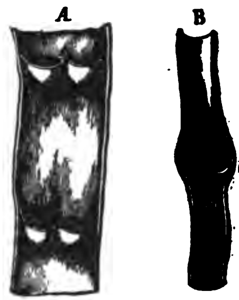


FIGURE 39.—Valves of the Veins. A, vein spread apart; B, section lengthwise through the vein.

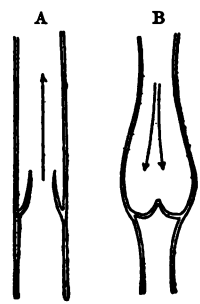


FIGURE 40.—A. Valve open. B. Valve closed.

Arterial and Venous Blood Compared.—When the red blood corpuscles have a plentiful supply of oxygen, they are of a bright red color, and the blood in which they flow is a bright scarlet. This bright blood is found in the arteries, and is called *arterial blood.* After passing through the capillaries, these same corpuscles that were bright red in color have become dingy and dark, because they were robbed of their loads of oxygen by the tissue that was starving for the life-giving food, and were loaded down with impurities such as carbonic acid gas and other poisons. When they reach the veins they give the blood a darker, bluish, color. The blood found in the veins is called *venous blood.* Arterial blood has more oxygen; venous blood more carbonic acid. Arterial blood is purer than venous blood. Arterial blood brings oxygen to the tissues; venous blood takes carbonic acid back to the heart and lungs, where it is gotten rid of and breathed out or exhaled from the body. The blood is always kept moving in the three sets of blood vessels or tubes—the arteries, the capillaries, and the veins. What keeps the blood in constant motion?

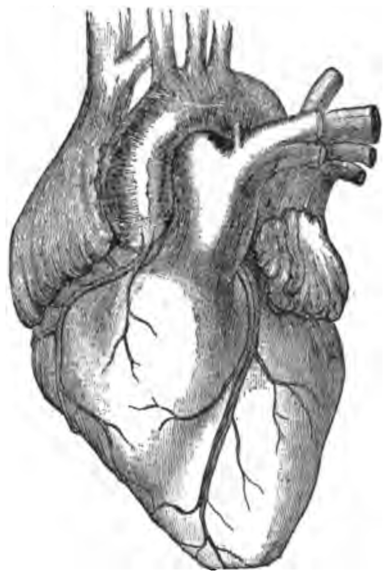


FIGURE 41.—The Heart.

The Heart.—If you place your hand over the chest a little to the left of the breast-bone, you will find your heart beating steadily in a machine-like manner. The heart is really a live pump that keeps pumping away as long as we live. If it stops pumping we die. If you count your heart-beats as you stand still, you will find that there are about eighty per minute. When we run and jump, or go rapidly upstairs, the heart beats much faster than when standing or sitting. The heart is made up of involuntary muscles, and is almost the size of its owner's tightly doubled fist.

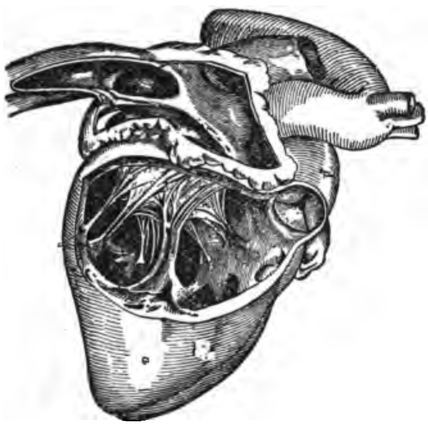


FIGURE 42.—Showing Cavities of the Heart.

The heart lies to the left of the middle of the body, and just below the level of a line drawn connecting your two armpits. The heart has four chambers or cavities. First, it is divided lengthwise by a firm, tough muscle wall so as to make two bags. Each half is a complete bag, and each is also a complete pump. The lower part of each side of the heart is called a *ventricle*, while the upper portion of each half is called an *auricle*. The middle muscle wall that divides the heart lengthwise from the base of the point, or apex, has no direct openings, so that the ventricles are not connected with each other, and the auricles do not open into each other. Each ventricle has two openings.

The gateway at the upper part of each ventricle opens from the auricle just above. This hole has a valve-like gateway, which is easily and tightly closed by two curtains. An opening in the side furnishes a passageway into an artery. The blood cannot get back from the ventricle into the auricle. As soon as the ventricle becomes filled with blood, the muscles that form its walls contract, making the ventricle smaller. This squeezes out the blood so that it goes into an artery.

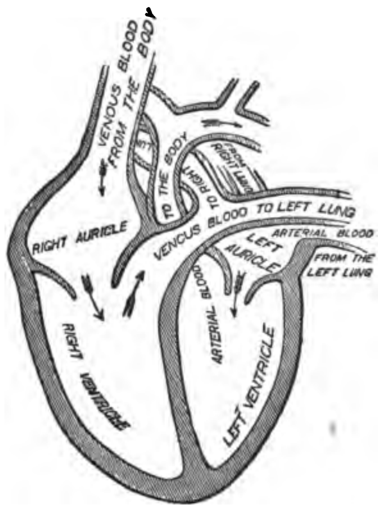


Figure 43.—A diagram, showing Course of the Blood Through the Heart.

Course of the Blood Through the Heart. — You can follow the course of the blood as it passes through the heart by closely observing the accompanying diagram. The venous blood first enters the heart at the right upper chamber, or anteroom, called the right auricle, and passes down through the valve-like gateway into the right ventricle. The right ventricle, by suddenly squeezing itself when it becomes filled, sends the blood to the lungs to come in contact with the air we have inhaled, and the blood thus becomes purified and bright red again, the corpuscles having rid themselves of their load of poisonous carbonic acid, and having taken up a fresh load of oxygen from the air. This purified and enriched blood then

passes to the left auricle, the upper chamber at the left side of the heart. From here it passes into the left ventricle, which, as soon as it becomes filled, suddenly squeezes its muscle walls together and forces this new arterial blood to the various parts of the body through the arteries and capillaries, from which it passes through the veins back to the heart to take the same journey over again. It takes from twenty to thirty seconds to send a drop of blood on such a "round trip" as we have described.

Why the Heart Beats.—You have learned that food, water, and oxygen are taken into the blood, and that this "vital fluid" contains all the food needed to repair the wasted tissues as they wear out from constant use. But if the blood simply remained in one place, and was not forced about, it would not do any good. It would soon get rid of its food, become loaded with poisons from the waste substances, and the various parts of the body would gradually die. You have noticed, if you ever wrapped a rubber band or thread tightly around your finger, that the part thus shut off from the active blood coursing to and fro from the heart, became so numb and cold that it was practically "dead." If the blood stood still, every part of the body would be quickly affected in the same way. The heart beats in order to keep the blood in continual motion. It does not make as much noise as does the snorting fire-engine as it squirts the stream of water over the fire, but it does its work just as effectively. The heart has two important nerves connected with it that regulate the rapidity of its beats. One nerve causes the heart to go faster, as when we have been jumping or running, or going upstairs in a hurry. The other nerve makes the heart slow up if it tries to go too fast. These two

nerves are the heart's regulators, in the same sense as a watch or clock has its regulators to fix its rate of movement.

Why the Heart is Double.—The heart is wisely arranged in having two similar sides, or halves. The one half receives the blood from the body and sends it to the lungs to get oxygen from the air. While the right auricle and ventricle are thus occupied, the left side is busy sending the newly enriched blood to the various parts of the body, and in this way the heart is enabled to do double the amount of work it could do, if, like the heart of a fish, it had but one auricle and one ventricle. The walls of the left ventricle are thicker and stronger than those of the right ventricle. This is because more force is required to send the blood from the left ventricle to the remote parts of the body than is required to send it from the right ventricle to the lungs.

The Amount of Work the Heart Does.—We can hardly realize the amount of work this busy little organ does each day and hour in keeping us alive. The heart beats, on an average, more than four thousand times an hour, and about a hundred thousand times a day. If all the force exerted by the heart in a single hour was used at one time, it would be enough to lift a big load, for it would raise over ten thousand pounds a foot from the ground.

The Heart Rests.—All the tissues of the body to be kept in healthy condition must have rest. The heart has its time to rest. It does not have long recesses such as you have in your school. Each recess is no longer than the time required by you to wink your eye. After each part has done its work by contracting its walls, it rests just an instant before it contracts

again, just as in walking one leg rests while the other is being used in taking a step. The rest periods of the heart are extremely short, only six-elevenths of a second, but if all the little short recesses were added up together it would make a total time of about thirteen hours each day. Are you not glad that the heart does not take all its rest at one time? What would happen if it did so? Is it not fortunate that the heart is a self-acting, involuntary muscle, instead of a voluntary one that had to be continually ordered to do its work, as we must do in the case of the hand or arm? How wide awake we would have to be to keep the heart going! We would have no time to do anything else—no time to do any work or engage in any play. We would never have a moment's sleep or rest, and besides we would not be able to keep it going regularly, and thus would not keep the body healthy. Nature has certainly acted wisely in making the heart self-acting.

How Fast the Heart Beats.—Sometimes the heart beats more rapidly, at other times more slowly. The heart is very easily influenced by our thoughts, our feelings, and the various physical activities. You know that it beats faster when we run upstairs, jump the rope, or run to the bases in playing ball, than when we stand still. It beats faster when we are standing than when we are sitting; faster when we are sitting than when we are lying down; faster when we are awake than when we are asleep. The more active we are, the more rapidly does the heart work. Why? Because when we are more active the tissues of the body wear away more rapidly, more waste matter and impurities are thrown off, and more fresh, pure blood is required by the parts of the body that

have been so actively engaged, and the heart must pump the blood faster to accomplish this.

Effect of Mental Activity on the Heart's Action.—Likewise, mental activity affects the rapidity with which the heart does its work. The kind of mental activity also makes a difference. The heart beats differently when we are engaged in reading a piece of poetry than when we are adding a column of figures. When engaged in hard study and severe mental work, there is more fatigue poison going from the tired brain into the blood than when the brain has but a small amount of work to do. Excessive mental activity makes the heart work faster in pumping fresh blood to the brain, just as great physical activity makes it send the blood more rapidly to the various parts of the body. Excitement, as in happiness, joy, anger, and fright, makes the heart beat rapidly. In sorrow, sadness, grief, or low spirits, it beats more slowly.

In Fever.—When one has a fever the heart beats more rapidly than when one is well, because more poison is thrown off into the blood by the various tissues of the body, and the heart works faster to do the extra work. When the fever is very severe and the temperature of the body very high, the heart cannot make the blood carry off these poisons fast enough, and some of the poisons and impure waste matters gather on the surface of the brain, making the fevered patient delirious.

The Pulse.—The pumping of the heart makes the blood go through the arteries in spurts or waves. At some places in the body large arteries, which are usually buried very deeply in the muscles, come near the surface. If the finger is placed on the skin at one of these points, these distinct waves can be felt

at each beat of the heart. This is called feeling the pulse. In men there are, on an average, about seventy pulse-beats a minute. In women the heart beats more rapidly than in men, making about eighty beats per minute. In old age it beats more slowly than in middle life, while in very young children there are often as many as one hundred and thirty pulse-beats a minute. Feel your pulse at the wrist or temple, and count the beats for one minute while you are sitting. Then rise and walk rapidly once around the room and compare the result with what you got while sitting. Also compare the pulse before and after eating a meal. Why does the physician feel the pulse of a sick person?

Sounds of the Heart.—The action of the heart is almost noiseless. Yet, if you place your ear directly over a person's heart, you will observe that each time the heart beats it makes two sounds. One sound quickly follows the other, and there is a short period of silence. These two sounds are not exactly like each other, but in a healthy person each of the sounds has its own peculiar character. The first of the two sounds is a comparatively long, booming sound; the second is a short, sharp, sudden one. In certain diseases of the heart, the character of these sounds becomes changed into a murmur or rumbling sound, so that a physician can tell by listening to the heart sounds whether this important organ is diseased or not.

Fainting.—Sometimes the heart beats with little force, or even stops beating for a brief period, and all parts of the body immediately begin to suffer. The brain, while it weighs but one-forty-fifth of the rest of the body, uses one-eighth of the total blood supply in the body. This being the case, it is natu-

rally the first to suffer from the weak action or stopping of the heart, even for a very brief period. When the brain is thus affected, and is starving for pure blood, the mind at once stops acting and the person *faints.* His face becomes very pale because it has little blood, and he is as senseless as in the deepest sleep. For this reason, when a person faints, we lay him down with the head low, so that the blood can get to the brain, and we rub vigorously the arms and legs *toward the body,* so as to compel the blood to go to his heart, and thus start this organ to begin its work again. By throwing cold water in the face of the person who has fainted, we make his heart beat harder. Very quickly the person revives, and is soon, apparently, as well as ever.

THE LYMPHATICS.

The lymphatic system consists of *lymph spaces, lymph tubes,* and *lymphatic glands.* The lymph *spaces* are minute chinks or crevices within the tissues in all parts of the body. The lymph *tubes* open out from the lymph spaces, uniting into larger tubes with valves very similar to those in the veins. (See page 112.) The main lymph tube is called the *thoracic duct.* Through it is conveyed all of the lymph except that from the right side of the head, neck, chest, and the right arm, and it empties into the veins at the left side of the neck. The right lymph duct, which drains the smaller portion of the body as above indicated, empties into the veins at the right side of the neck. The *lymphatic glands* are little kernel-like masses along the lymph tubes through which the lymph passes.

The Lymph.—Leaving the red corpuscles behind in the blood vessels, the fluid that leaks through to feed the tissues of the body is colorless. This becomes the *lymph.* It is really the blood minus the red corpuscles. Very little of it can soak back into the blood tubes because of the pressure of the blood within the vessels, caused by the heart's continual pumping, which forces the blood through the arteries. To take this lymph back to the heart, this other set of tubes, called lymphatics, is required.

FIGURE 44.—Lymphatic System of Right Arm.

The lymph always flows in one direction only—toward the heart. These tubes, then, that convey the lymph are like drain-pipes. They take up the fluid that has soaked out of the thin walls of the small blood vessels, and which bathes and feeds the tissues, and convey it away to be again poured into the blood at the large vein in the neck. It naturally contains much waste matter thrown off by the tissues, and must go through the heart along with the venous blood to be again made pure. The entire plan of the lymphatic system is to furnish a means of drainage for the body.

In the disease known as *dropsy*, the lymphatic vessels do

not work properly, and the tissues are filled with the fluid almost to bursting. The flesh in such a person may be compared to a piece of very wet, soggy, marshy land, the drain tiles of which are not in order, and do their work imperfectly.

The Work Performed by the Lymph.—The lymph is derived from the blood and is full of the proper food for the bodily tissues. Its work is to deliver to these tissues just the material needed to keep up health and the proper activity. After it delivers these food materials it must take up what is left, and what can be used by some other organ, as well as the waste products from the tissue cells. The office of the lymphatics, then, is to take up and carry from the tissues to the veins all the material that the tissues do not need. The tissue cells of the body get all their nourishment from the lymph, and into the lymph they must throw their waste matter.

The Spleen.—The spleen is an oblong, flat body that lies upon the left side of the stomach, and varies in size at different periods of life. Its size is increased after digestion, and is always large in well-fed and small in starved animals. In some diseases, such as ague, a very noticeable enlargement of the spleen takes place, and this is the so-called "ague cake," of which doctors sometimes speak.

The spleen is a reddish-gray, pulpy mass, and while the body has been carefully studied for many years, it is not yet known what work the spleen really has to do. It forms no secretion to be poured into any cavity like the liver and other glands. In case of accident and disease it has been removed by the surgeon's knife, and life continues without any serious results.

Massage.—By massage we mean a system of either gently or vigorously rubbing, pressing, or kneading the muscles. This greatly helps the flow of the blood and lymph, and by thus assisting circulation, does much toward washing out the waste particles of the body that can be affected by this rubbing of the skin. Massage, in a measure, takes the place of exercise. People who are sick and weak cannot take the exercise they should, and massage rubbing will prove a good substitute. It is an excellent thing for any one to rub the body with the hands or a dry towel, especially if it is impossible to take the exercise his health requires. A "dry rub" is thus frequently as beneficial to health as a bath.

The Circulation Modified by Alcoholic Drinks.—Alcohol diminishes the capacity of the blood to absorb oxygen. It decreases the working power and lowers the temperature of the body. Alcoholic drinks make the blood poorer in quality and thus impair the nutrition of the tissues.

The tendency of alcohol is to cause fatty matter to be deposited in the walls of the arteries, taking the place of the tough elastic material that should form these walls throughout. By this action of alcohol the artery is weakened. At the places where the fatty matter collects the walls of the artery are stretched by blood pressure, they become thin, and there is a pronounced bulging. This bulging of the arteries is called an *aneurism.* Eventually it may burst and the person bleed to death. Alcoholic drinks, as a rule, excite the heart and hurry its beat. The time of rest between heart beats is thereby shortened. The heart is overworked. An overworked heart in time naturally becomes a diseased heart.

Tobacco always tends to make the action of the heart irregular and less vigorous.

CHAPTER IX.

BREATHING AND THE LUNGS.

You remember that oxygen is a necessary food that the little red corpuscles carry all through the body. From this you know that plenty of air is as necessary as the food we eat. Without food, men have lived more than a month. Without water, one can live a few days. Without air, one can live only a few minutes. All living things breathe. The plant breathes by means of its bark and leaves. The little insect, or the tiny ant, depends for its existence upon air as much as you do. The angle worm, which you may have used to bait your hook when fishing, breathes through its skin. In human beings there is a very beautiful and perfect arrangement by means of which the air needed for life and health may be plentifully supplied.

Why We Breathe.—You remember that in the last chapter we were told that the bright red, pure blood was carried by the arteries to every part of the body. As this blood goes through the arteries it gives up its food to each part as needed. The blood then becomes darkened by the impurities it takes up, as well as because of the oxygen the little red corpuscles have given off, and is carried back to the heart through the veins. But the heart cannot send this used, impure, and poisonous blood back to the different parts of the body. So, as soon as

the blood gets into the right ventricle of the heart, it is forced, by the heart's pumping movements, to the lungs. In the lungs the dark, impure blood is changed to bright, pure blood again. The lungs, then, are very important organs, since, by means of them, the blood is purified and again rendered fit for use. We shall study the lungs and their work in this chapter.

Can you see any veins in the back of your hand which look like blue lines under the skin? As you examine them you find that they are blue or purplish in color. Certainly they do not appear to be bright red. But if you cut your finger, or prick it with a sharp needle, the blood that comes out is bright red. What has changed it from the dark blue or purple color to red? The air. Just the instant the air, or rather the oxygen it contains, comes in contact with the blood, it changes it to bright red. The lungs have for their special work the carrying of the air to the blood without interfering with its circulation through the body. How is this done? In the lungs the air gets very near the dark, impure blood, feeds it oxygen and changes its color to a bright red by mixing with it. The blood gets fresh air from the lungs, and in turn gives up to the lungs certain impurities that have been collected in passing through the body. These are sent out from the body

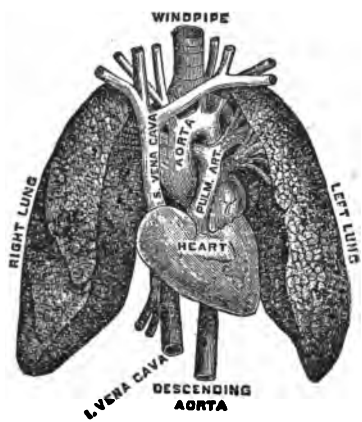


FIGURE 45.—The Lungs and Heart, front view.

when we exhale air, just as oxygen is brought to the blood when we inhale fresh air.

How We Breathe.—We must now study more closely this important work of the lungs. In breathing, air is taken in through the nose to the back part of the mouth (called the *pharynx*), and through a tube in the neck to the lungs. This tube in the neck is close up against the food-pipe, or esophagus, and is called the *windpipe*, or *trachea*. If you feel the front of the neck with the fingers and thumb, you will easily discover the windpipe. It is a pile of hard rings one on top of another. These are not completed rings but are C-shaped, or like horseshoes. They are arranged on top of each other with the opening of the horseshoe toward the back of the neck.

The windpipe first divides into two main air tubes, each called a *bronchus*. This division occurs four or five inches below the back part of the mouth. One of the bronchi, or large air tubes, goes to each lung. Below this main division the air tubes divide again and again, many times, until we have the finest possible air tubes, like the little, fine, netted veins of a maple leaf. At the end of each of these little tubes is a tiny air sac. There are thousands upon thousands of these air sacs, and together they make up the two lungs. A lung is a soft, spongy piece of flesh made up of a collection of air sacs. Each air sac of the lung is like a little toy balloon, filled with air each time we inhale. You feel and see your chest expand as each one of these thousands of air sacs is filled. When the breath rushes out as we exhale, the chest falls again. Take a tape line and see how many inches you measure around your chest when you inhale and fill the lungs—every air sac—with all the

air they can contain. Now exhale every particle of air that you can, and measure your chest to see how much smaller it is.

The lungs fill the upper part of the body just below the

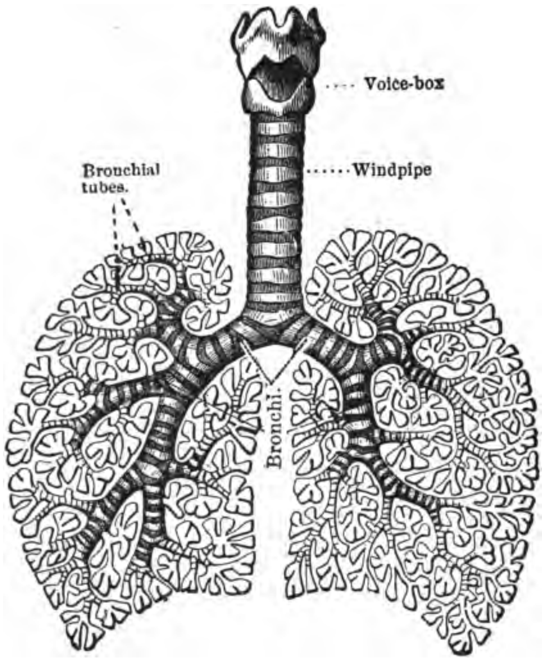


FIGURE 46.—The Air Tubes and Air Cells.

neck, and are covered by the bony framework of the ribs. They rest on a broad band of tough muscle, called the *diaphragm.* The upper part of the trunk above this muscle is called the *chest,* and contains the heart and lungs. The lower part, that below the diaphragm, is called the *abdomen,* and contains the

intestines, stomach, and liver. The diaphragm is a partition made of muscle, the edges of which are attached to the lower ribs. This partition between the chest and abdomen is not straight across, but dome-shaped or arched upwards.

The Two Breaths.—In inhaling, the arch of the dome-like diaphragm is lowered, the ribs bend outwardly, and the air rushes in through the nose and swells out the lungs to the size of the chest. This is called *inspiration.* Then the chest again becomes smaller by the ribs bending in toward the backbone to their former position, and by the diaphragm arching itself higher to its former shape and expelling the air from the lungs. This out-breathing is called *expiration.* The action of the lungs is very much like that of a pair of bellows. When you take a long breath the air rushes into the lungs just as it does into the bellows, and you feel your chest expand as the little air sacs are filled, just as you see the bellows at the blacksmith's shop get larger when they are filling with air. When the breath is forced out by the contracting chest, we have the same sort of thing that occurs when the blacksmith pulls on the handles of the bellows, making them force the air out. Your dog pants noisily and rapidly after running a considerable distance. Does it not remind you of a small, noisy pair of quick-acting bellows?

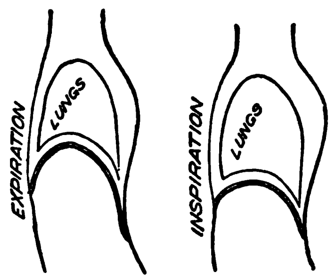


FIGURE 47.—Illustrating the position of the diaphragm in expiration and inspiration.

An adult breathes about eighteen times a minute. That

is, one breath is taken to every four beats of the heart. We do not seem to rest in breathing, but inasmuch as the breathing muscles work only during inspiration, and not in the act of expiration, they rest about half the time. The lungs like the heart work very hard, and we should give them plenty of room by avoiding tight clothing. They should also have plenty of fresh air that their work may be made as easy as possible.

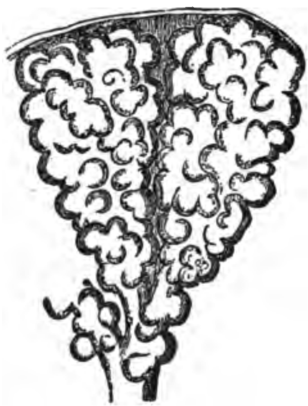


FIGURE 48.—Showing a group of Air Cells, greatly magnified.

The Nostrils and Soft Palate.—The air finds its way back to the lungs through the mouth, or the two openings of the nose, which are called *nostrils.* We should breathe through the nose rather than through the mouth, for reasons that will be stated later. The nostrils are air-passages leading back through the nose. These again come together in an open space at the roof of the mouth behind the soft curtain that hangs down at the back part. This curtain is called the *soft palate.* Through the opening behind the soft palate the air passes down through the windpipe and into the lungs.

The Windpipe and Air-Tubes.—You have already learned that the large tube, called the windpipe, extends from the root of the tongue down into the chest where it divides into two branches, one going to each lung. These branches are subdivided again and again into hundreds of little branches, until

they are no larger than the finest needle. The air-tubes are called the *bronchial tubes,* and at the end of each is a group of air cells such as you see enlarged in Figure 48, where they are puffed out as they appear when filled with air. You observed, on feeling of the windpipe at your throat just above the point of "Adam's apple," that it is hard and gristly, made of rings of cartilage piled upon each other. The air-tubes, even some of the small ones, are made of the same hard rings, but in the smallest branches they disappear. If the windpipe were a soft tube of membrane, like the esophagus, it could not be kept open continually for the air to pass through, and we would smother or choke to death. If a piece of tough meat, improperly chewed, lodges in the windpipe, instead of the esophagus, the air is shut off from the lungs, and the person dies, unless, by means of the fingers, the obstruction is pulled out and the air permitted to rush into the lungs before it is too late. In some diseases, such as *croup,* the air-tubes and windpipe become obstructed with an exudate or mucus, sometimes smothering the child to death. If, however, in such a case, the person so afflicted will inhale the steam from slacking lime, relief quickly comes, for this steam cuts through the thick mucus, or phlegm, and opens up the tubes so air can again get to the lungs. In *diphtheria* the throat sometimes swells shut, so that air cannot enter the windpipe. Then the doctor saves the patient's life by cutting into the throat and inserting, through the muscles of the neck into the trachea, a glass tube, which serves as an artificial windpipe, permitting the patient to breathe comfortably until the throat again opens to permit the passage of air in the natural way. In drowning, water

enters the lungs, shutting off the air, producing death in less than five minutes. At any time before death actually takes place life can be restored by means of artificial respiration, which will be described in a later chapter. At the outer end of the smallest tubes within the lungs, next to the tiny air sacs, there are no rings of cartilage to keep the tubes wide open, but little muscular fibers instead. As a result of disease these fibers sometimes shrivel and contract, making the tube opening much smaller, and it is sometimes a hard matter for the suffering patient to get the air through in either direction. This condition is very painful, and with it there is a sense of smothering. The disease is called *asthma.* In the disease known as *pneumonia,* as a result of inflammation, many of the little air sacs are filled with a fluid. This fluid is often in so great a quantity as to necessitate its being drawn off from the lungs by inserting a large, hollow needle, in order to save life.

Sounds of the Chest.—The lungs make certain peculiar sounds in breathing. In health the sounds are quite different from what they are in lung diseases. The doctor listens to these sounds to tell whether the lungs are healthy or not, and in this way can detect a case of croup, lung fever, or pneumonia.

The Voice-Box.—Close under the chin at the top of the windpipe you find a large lump which moves as you swallow. This is a little box at the opening of the windpipe, and is made of pieces of gristle or cartilage almost as hard as bone. It is called the larynx, or *voice-box,* because by means of it we are able to speak, sing, or read aloud. Two little white bands stretch across this voice-box, and when we speak these bands or cords vibrate as do the strings of a violin, banjo, or piano.

These little bands are called *vocal cords.* The kind of sound we make depends largely on the tightness with which these vocal cords are stretched within the voice-box.

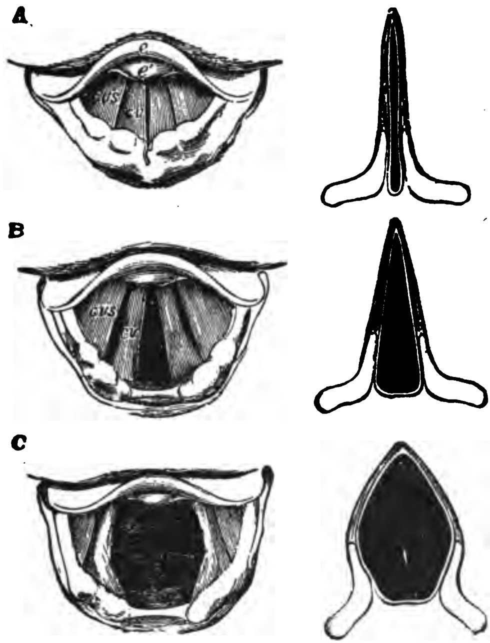


FIGURE 49.—A. Appearance of the Vocal Cords in singing a high note. B. The V-shaped glottis as seen in quiet breathing. C. Round appearance in deep breathing.

The Epiglottis.—At the top of the larynx, or voice-box, is located a peculiar trap-door which can open or shut just when it should do so without our thinking especially about it. It is called the *epiglottis,* and closes down over the top of the larynx whenever we swallow anything, keeping food and drink from

entering the air-passages of the lungs. If we eat or drink too rapidly, this little trap-door does not have time to close itself, and thus prevent our being choked. Did you ever get a crumb in your windpipe? How it made you cough! But this coughing expelled the air rapidly from your lungs and forced the crumb up into your throat again.

The Pleura.—In the chest the lungs are covered and enclosed by a soft, moist, very thin membrane, called the *pleura*. The interior of the chest walls is also lined with a similar membrane or pleura. In a healthy condition these two membranes keep themselves moist by continually exuding a small quantity of fluid. This moisture keeps them smooth, and when they rub together as we breathe, the two lungs in moving are not irritated, and breathing is painless and easy. Sometimes, as a result of cold, this membrane becomes inflamed, and breathing becomes exceedingly painful and difficult. This disease is known as *pleurisy*.

Slow Burning within the Body.—The human body is in many respects like a stove. In the stove we put fuel; the fuel is consumed, and we get heat. In the body we consume food as fuel; it is slowly burned, and we get heat from this food-fuel. The tissues of the body are slowly burning or oxidizing all the time, that is, substances from the bodily tissues unite with the oxygen of the air.

Put a piece of bread into a hot stove and it quickly burns. The larger part of it passes off as smoke and gases into the air. Only a few ashes remain. A fire to burn well must have plenty of air. You open the damper of the stove to give more air, making the fire burn better. Air must unite with some

substance in every fire, else there would be no burning, and no heat. The blood carries food through the body, and its red corpuscles bring the important element of air—oxygen—from the lungs. The food and air join together in a slow process of burning. The gases (smoke) are carried back to the lungs to be forced out of the body. The ashes are gotten rid of by means of the skin and kidneys. By the slow burning of food within the body the proper degree of warmth is kept up, and besides, some of the resulting heat is turned into strength by means of which the body does its work, just as the steam-engine gains its power from the fuel it consumes. The amount of heat produced in the body in a single day is the same that would result if the amount of food daily eaten were burned outside the body. The body is more like a steam-engine than a stove, for both have the power of motion. Both move, both use fuel (food, coal), both take in air, both are warm, both give off smoke. In the body the smoke is invisible except on a frosty day, but in both it is quite the same thing; carbonic acid gas and water being the chief things which make the smoke in both cases.

The Air—Before and After.—Fresh air contains oxygen. Oxygen sustains life. Carbonic acid gas destroys life. We breathe in order to get oxygen from the air into our bodies, and to drive the poisonous carbonic acid gas from our bodies into the air. The blood, while in the lungs, unloads the carbonic acid gas and other impurities it has collected from all parts of the body to be exhaled, and loads up with oxygen from the air that has just been freshly inhaled. Exhaled air contains, then, certain poisonous matters. 1. Carbonic acid gas. 2. Invisible

poisonous gases arising from decaying animal substance, and called "organic waste matter." This animal substance you can readily detect by its odor as you enter a crowded room that is not properly ventilated.

In each breath, then, we trade something that is life-destroying (carbonic acid gas and organic waste matter) for something that is life-giving (oxygen). But we cannot breathe pure oxygen. It would cause too rapid burning within the body. Hence, in the air we breathe, oxygen is diluted by being mixed with nitrogen. There is a very small amount of carbonic acid gas in the air we inhale. The air we exhale contains one hundred times as much of this poisonous gas as the air we inhale. In each breath, we rob the air inhaled of one-fourth of its oxygen. Look at this table which shows the composition of 100 parts of inhaled and exhaled air:

	Oxygen.	Nitrogen.	Carbonic Acid Gas.	Organic Waste Matter.
Inhaled air - - - - -	21	79	.04	0
Exhaled air - - - - -	16	79	4.00	1

Nose and Mouth Breathing Compared.—It is a very harmful practice to breathe through the mouth instead of through the nose. Air should always reach the lungs through the nostrils, which are devised by nature to strain the air, to warm it, to moisten it when too dry for the lungs. The nostrils being also the seat of the sense of smell, we are thus warned when the air is impure. If a person persists in breathing through the mouth, the throat becomes dry, cold air will chill the warmer blood in the capillaries of the lungs, and the particles of dust will not be strained out, which alone may cause much harm.

If one breathes through the mouth habitually, the lungs are sure to become diseased. One of the easiest ways to prevent taking cold is to breathe through the nose.

Adenoid Growths.—In the back part of the nasal passages, more especially in rapidly growing children, are frequently found in little grape-like clusters, a form of growth that obstructs free breathing through the nose. These growths are called *adenoids*, and can readily be removed by any skillful physician. They should never be allowed to remain, for they not only interfere with breathing, but they cause defective hearing, which is just as great a misfortune to a school child as defective vision. If the pupil cannot hear the teacher's questions perfectly he cannot answer them correctly. If he cannot hear distinctly the teacher's explanations, how can he have a clear understanding of the problems explained? A large number of schools have wisely arranged to test the vision and hearing of all the pupils. The pupils who cannot hear well or are near-sighted are placed in the front part of the room where they can see the blackboard or hear the teacher's explanations with less difficulty.

As a result of habitual mouth-breathing, the face is distorted, the upper lip becomes shortened and thickened, the upper teeth stick out, and the face loses its pleasant expression. All these mouth-breathers have defective hearing, and do you know that every true case of stupidity in school children exists in connection with defective hearing and mouth-breathing? You know how hard it is to give attention to study when you have such a severe cold that the nostrils are "stopped up," and for the time you can breathe only

through the mouth. The habitual mouth-breather has the same uncomfortable feeling all the time. He cannot study well. He cannot give the best attention. A physician should always be consulted when mouth-breathing has become a fixed habit.

One Boy's Debt.—From several hundred letters received by me from teachers and school superintendents, I select the following to show you how serious adenoid growths are. Archie, the little boy mentioned in this account, entered the first primary grade at the age of six years. The end of each succeeding year, for four years, found him larger and stronger physically, but mentally incapable of any better work than he did in his first school-year. At the beginning of his fifth year the teacher was obliged to continue him in his Second Reader, telling him, however, that he still ought to be in his Primer. His superintendent says: "One day in November I began noticing him. There he was, a boy eleven years old, sitting idly, his under jaw hanging down, vacant-eyed, and that utterly expressionless face which we find in idiots. He seemed to take no interest in what was going on around him; when called upon to read he had lost his place, and his teacher scolded him for what she supposed was carelessness. The next morning I found Archie in one of the stores with some other children looking at the Christmas toys displayed on every side. I asked him what he wanted Santa Claus to bring him; he pointed to a little 'dumb watch.' But I said, 'Archie, why not wish for a watch like mine that ticks loud and runs. Just listen, now, and hear my watch tick.' I thus tested the little fellow's hearing, and found that he could hear my watch tick

only when within *a few inches* of either ear, while I could hear it easily at twenty feet. I felt that I had a clew. I took him to my own physician, who examined him, finding at the back of the nose adenoid growths, which had affected his hearing; in a moment he removed them, and the boy went back to school. The doctor and I told no one of what we had done, not even his parents or his teacher; in fact I did not mention it in my home, for reasons which you will understand later. In about three weeks from the time the operation was performed, my little son, who is in the same room with Archie, said at the dinner-table, 'Papa, you ought to see how fast Archie is learning; he gets all the head marks in spelling, and he beats us all in reading.' His teacher next came to me and said, 'What have you done to Archie? His improvement is wonderful, he is the brightest one of his class.' I explained what had been done for the poor little fellow whom we had so mistreated for almost *five years.* At the close of this term's work Archie stood at the head of a class of twenty-two; for almost five years he had been at the foot."

Foul Air.—Air may be polluted in various ways. The following sources of foul air are among the most common: *Cellar Air.* Cellars are kept closed; thus no light and but little fresh air can enter. The decaying vegetable matter gives off injurious gases that cause disease. Diphtheria is often caused by the foul air arising from the cellar under the house. Unless the cellar is so built as to admit sunlight and fresh air, and is frequently cleaned, it becomes a reservoir of foul air, capable of causing much sickness that could be avoided. *Coal Gas* is frequently used in towns and cities for lighting, and it is a

deadly poison to the lungs. It sometimes escapes in large quantities from leaky gas-pipes, or it may be sent out into the room by a stove that does not draw well. Great care should be taken to prevent coal gas from mixing with the air we breathe, especially in our sleeping-rooms. Death by *asphyxia* frequently results from carelessness in this respect. *Sewer Gas* is a poisonous product arising within the drain-pipes of houses because the plumber did not properly construct them. In most of the cities and towns the plumbing of houses is under some sort of supervision in order that the possibility of sewer gas may be avoided, thus preventing many cases of fever, diphtheria, and other diseases.

Malaria.—A house or school building should never be located on low, flat ground, near a marsh or swamp. Air from stagnant water, or wet earth, may be full of disease germs. Malaria (ague, chills and fever) is always caused by these germs. A schoolhouse or a residence should always be built on a knoll or rise of ground, where perfect drainage may be had. If there is perfect drainage the soil about the building cannot remain wet, and will not become "sour," serving as a breeding place for disease germs.

Dust.—If the fine dust particles in the air are not too plentiful, the moist lining and the little hair strainers of the nose will prevent their getting into the lungs. Rain and snow storms wash the dust out of the air, making it fresh, sweet, and clean. Soft coal, where it is used to a great extent, is a source of irritating dust. All dust entering the lungs is harmful. For this reason it is much better to have the playgrounds about our schools in sod rather than covered with cinders or dry earth.

There will be less dust, therefore, less disease. In some occupations laborers are continually exposed to the danger of inhaling large quantities of dust. Coal miners, pottery workers, pearl button makers, flax workers, and tool grinders, are especially liable to asthma and similar diseases because of the dust-laden atmosphere with which they are surrounded while they work. The dust continually entering the lungs finally weakens them by causing repeated inflammation of the air-sacs and smaller air-tubes. On the other hand, certain of the finest laces can be made only in damp rooms. In some cities of Europe many poor women are employed in making this lace. They never live over three or four years, if they continue their work, because the damp air produces rapid consumption of the lungs. We have, then, a number of "occupation diseases," that is, diseases caused by the improper and unhealthful conditions amidst which certain occupations are carried on.

Ventilation.—Enough has been said about the dangers of breathing impurities to show the necessity of a plentiful supply of fresh air in our houses, schools, halls, churches, and other meeting-places, which are often so poorly ventilated. In earlier days when our houses were heated by open fireplaces with their big "back-log," there was a roaring draught up the chimney, making perfect ventilation. To a great extent stoves are now used in place of open fireplaces. Stoves do not use much air, and consequently do not serve as a good means of ventilation. Steam and hot-water pipes are very satisfactory for heating, but when they are used we must provide some method for bringing in fresh air. Hot-air furnaces bring in fresh air that is heated on the way into the room. When a schoolroom is

heated by a stove, it should have a sheet-iron shield or jacket about it. As the air about the stove becomes heated it rises, and cold air rushes in under the jacket to take its place. Such an arrangement heats the room more evenly and prevents the pupils near the stove from being overheated. It is an excellent idea to have small ventilating flues built into the chimney around the smoke-flue or hole where the stove-pipe enters the chimney. These small ventilating flues furnish good outlets for foul air.

But a perfect system of ventilation provides an inlet for fresh air as well as an outlet for impure air. No system of ventilation is complete unless it provides both of these features. To insure perfect health there should be for each person more than a cubic foot of fresh air every minute. If there are forty pupils in your school, there should be such perfect ventilation that forty bushels, or a big wagon-load, of fresh air can get into the room every minute, and an equal amount of foul air be gotten rid of in the same time. Fresh air is a necessity. If it does not enter the schoolroom in sufficient quantity, the pupils become drowsy, languid, and begin to have what doctors call school-headaches. Children can never do the best school work without fresh air. It is a prime necessity to mental as well as healthy physical growth. We know that in schools where there is poor ventilation there is much greater likelihood of the pupils "catching" diseases. We also know that in such schoolrooms children do not make the same rapid progress in mental growth that they do in those that are well ventilated. Pure air in our schoolrooms means better lessons, clearer brains, fewer headaches, and more genuine enjoyment in our work.

Every school should have a recess each half-day, and during these recesses all the children should go out of doors, not only to play in the open air and fill their lungs with oxygen, but also to give the teacher an opportunity to open the windows and completely air the schoolroom. Class-rooms should be ventilated winter and summer at each recess and noon period, by opening all the doors and windows. While such ventilation is going on, the pupils in the yard or halls are not only getting exercise, but will also bring back with them fresh air in their clothes. The time spent in recesses will be more than made up by better work when school again assembles after such an intermission, for the brain will be quicker and the work will seem easier. The Prussian Minister of Education requires that the windows of the class-rooms shall be open all night in summer weather; when the weather is cold they are kept open from the close of school till dark, and from four in the morning until school opens at seven o'clock.

How to Ventilate.—If there are no foul-air shafts for the escape of impure air, and no inlets for fresh air, a good method is to raise the lower sash of a window, and place a board under it so as to completely fill up the window casing. This will establish good ventilation between the two sashes. This method provides for constant change of air, and yet prevents draughts of air from entering the room and causing "colds." The schoolroom and the living-rooms of a house should be kept at a temperature as near 70 degrees Fahrenheit as possible; sleeping-rooms should also be well ventilated, since we spend about one-third of our lives in them. In our sleeping-rooms the temperature should not be above 60 degrees Fahrenheit.

Cleanliness of Schoolrooms.—If cleanliness does not exist in the schoolroom, no amount of ventilation will correct the evil. The pupils themselves can help a great deal in this matter by keeping their bodies perfectly clean, and also their clothing and shoes. There should be scrapers and foot-mats where shoes can be quickly cleaned before entering the schoolroom, and there should be basins provided where children can wash themselves when necessary. Cloaks, overcoats, hats, caps, gossamers, rubbers, umbrellas, all give off unpleasant odors, especially when wet, and on this account should never be taken into the schoolroom, but should be placed in the hall or the especially provided, well-ventilated cloak-rooms found in our best modern schoolhouses.

Very often schoolrooms do not have the proper kind of floors. Floors that collect a large amount of dirt and dust endanger health. If the boards of the floor are too soft, they sliver easily, and these slivers grind into dust, and besides, they hold moisture too long after being scrubbed, making the room smell musty. Close-fitting, "matched" flooring of maple, oak, or hard pine makes the best floor. To avoid raising dust the floor should be first sprinkled with wet sawdust before sweeping. Dry sweeping does not remove the dust, but simply drives it from one place to another. Schoolrooms should be swept daily and scrubbed often. Linoleum makes a good floor-covering. It is easily swept and washed, and deadens the noise made by the pupils' feet. It is in every way better than the coarse cocoa matting so often found in the aisles of schoolrooms. These are always collectors of dust and disease germs. The dust-trough that runs along the lower edge of the black-

board should be cleaned every evening after school. Only good, soft blackboard erasers should be used, and they should be dusted at the close of each school day. Each pupil in the school can do a great deal toward keeping the schoolroom clean. Since dirt breeds disease, and cleanliness insures health, is it not the duty of every child in your school to help the teacher in keeping the room as clean as possible?

Effect of Alcohol on the Lungs.—Alcohol acts directly on the "breathing center" in the spinal bulb at the base of the brain and thus diminishes the amount of air taken into the lungs. The walls of the minute air sacs may become so thickened as to be less elastic and their size thus gradually decreased. The breathing capacity of the lungs is thereby reduced.

EXERCISES.

1. In a history or encyclopedia read an account of the Black Hole of Calcutta.
2. What are the facts concerning the Grotta del Cane and the Upas Valley?
3. Discuss Fire Damp, Black Damp, and Choke Damp, that often work such serious injury to men working in mines.

CHAPTER X.

THE NERVES AND THE BRAIN.

You have already learned that the human body is made up of many parts, each of which has its own particular work to do. Stomach, skin, liver, bones, kidneys, muscles, heart, and lungs—each has a special task to perform, but all must work in harmony with each other in order that the body may act as a whole and be kept healthy. All of these members of the body must be under the control of some central authority or government; they must be parts or members of a great system, just as the parts of a complex piece of machinery, for example, a locomotive, are under the control of an engineer. This control and direction of all the parts of the body in relation to each other, is in charge of and is exercised by the nervous system.

The Nervous System.—The term "nervous system" refers to all the nerves of the body, and includes the brain and spinal cord. The general object of the nervous system is to connect, control, and direct the actions of the different parts and organs of the body, so that they will work in harmony. Let us illustrate. You run the bases in a ball game: your heart beats more rapidly, more blood is pumped through it to the lungs, and more oxygen is required. You therefore breathe faster. The presence of the food in the mouth calls forth saliva from the glands, and a little later causes the gastric juice to flow from

the lining of the stomach. You stand looking down the road, and a little grain of dust gets into your eye. When this happens, the tear gland of the eye tries to wash out the cause of the pain. You are frightened. The cold chills run up your back, your heart stops beating for a moment, and then you run. Your finger tip touches a hot iron, and you quickly jerk your hand away. A little snake runs across the path on your way to school, and before you know it you stop still, and if you are afraid, you shudder. There is something that makes all these organs and parts of the body work at the proper time. This something is the nervous system.

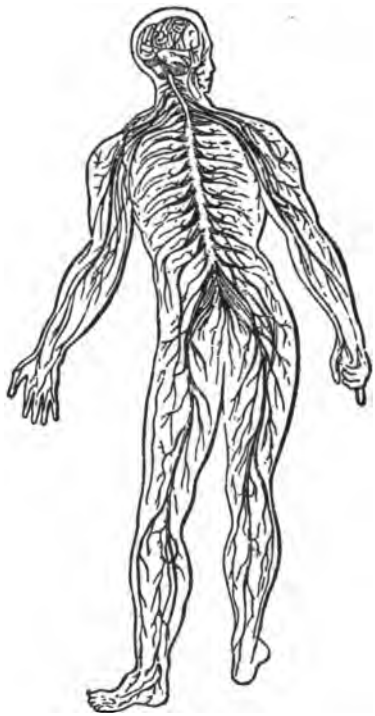


FIGURE 50.—Nervous System of a Man.

A thing that is not alive does not respond when touched or handled. If you handle a piece of iron, a lump of coal, or a block of wood, there is no movement in answer to your touch—there is "no sign of life." Suppose you are walking through the busy streets of a great city, and you jostle against a lamp-post, barber-pole, or tree. You find that none of these objects are the least disturbed. There is no response of any sort

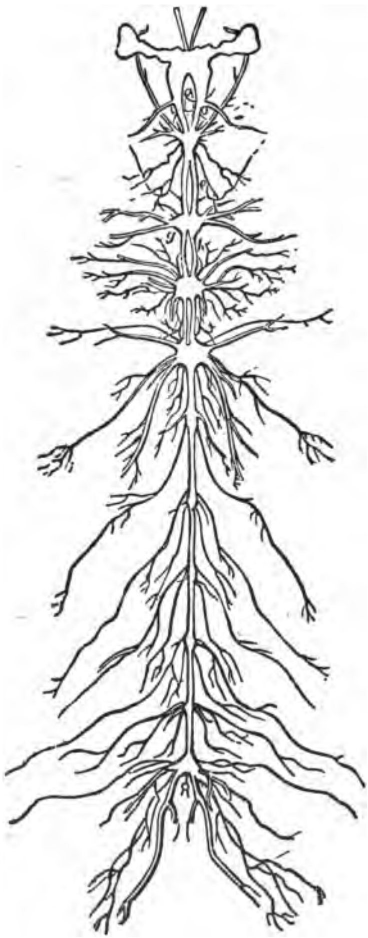


FIGURE 51.—Nervous System of a Grasshopper.

on their part. You, however, respond with a sudden start, your face changes expression, you almost lose your temper. With your hand you rub the bruised part of your body. You *feel.* The lamp-post, barber-pole and tree *do not feel.* Or, to express the same thing in a different way, you have a nervous system; the other things have no nervous system.

Nerve Messages.—The nerves are very much like telegraph wires. Your head contains something quite similar to a telegraph office. The brain in the bony skull-box is the central instrument that sends out and receives messages, and the little white thread-like nerves running all through your body are the wires connecting every part of it with the brain. You wish to write your name. The brain sends a message to the hand, and it begins to move in just the way it should to make the letters composing

your name. The message is taken from the central office, or brain, to the muscles of the hand by means of the nerves in almost the same way that a telegraph or telephone message is transmitted along copper wires. This is a *motor* message, being an order to move. Or, perhaps a bee stings you on the hand; at once a message is sent rapidly along special little nerve-wires to your brain, and you have a sensation of pain. This is a *sensory* message. It conveys a sense impression to the brain.

FIGURE 52.—Section through a portion of the human Brain; showing the number and depth of the convolutions and the arrangement of white and gray matter.

The Parts of the Nervous System.—The nervous system consists of (1) the brain, (2) the spinal cord, and (3) the nerves to and from the brain. The brain and spinal cord are called nerve centers. The reason for that we shall soon see. The nervous system is composed of two kinds of substance in every way different from each other. One of these is the "white matter," the other the "gray matter." Nervous tissue is the finest tissue in the whole body. It is the "master tissue," for it controls, directs, and regulates all other tissue.

The Brain.—By the brain is meant the whole mass of nervous matter which is contained in the bony box called the skull. On the outside it is grayish in color. Under its gray cells the

brain is white, for this part consists of nerve fibers. It is within the brain that the nerve fibers begin. The brain is connected, either directly or indirectly, with all parts of the body.

The human brain is not smooth, as are the brains of the owl, parrot, frog, chicken, squirrel, or marmoset. Instead of a smooth outer surface it has many folds, or wrinkles, as you see on page 151. By observing closely you will find that in the human brain these wrinkles are greater in number and deeper than in the brain of the cat or monkey. The older we grow, the

FIGURE 53.—Brain of Parrot.

FIGURE 54.—Brain of Owl.

FIGURE 55.—Brain of Cat.

more we are educated, and the more our brains are developed, the more numerous and deeper do these folds become. The fissures between the folds, or convolutions, furnish nice little channels through which the rich, red, arterial blood can flow over the surface of the brain to feed and nourish the hard-working cells that are continually hungry for oxygen. The brain needs a very large amount of blood in order that it may do the great work it has to perform. While the brain weighs only one-forty-fifth as much as the rest of the body, it uses one-eighth of all the blood in the body. To do its work, to grow, to become

AVERAGE HUMAN BRAIN.

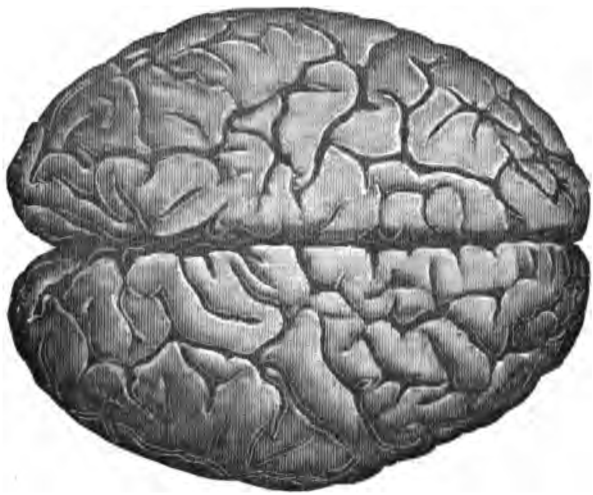


FIGURE 56.—Viewed from above.

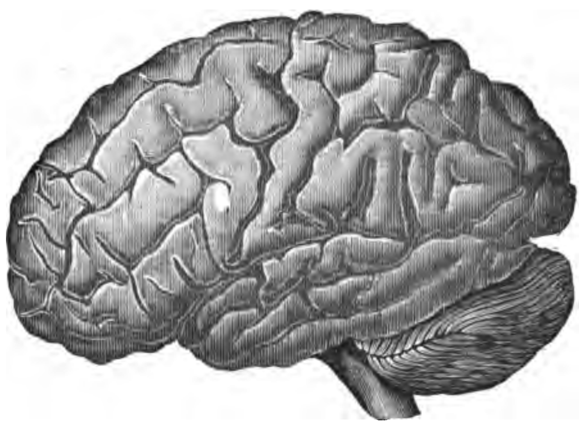


FIGURE 57.—Side view.

educated, and to keep in good health, the brain must have an abundance of rich, pure blood. The more the blood flows over the brain surface, the deeper do the fissures become, and the greater their number. This makes it correct to say that the greater the number and depth of the fissures of the brain, the more intelligent and better educated is the person.

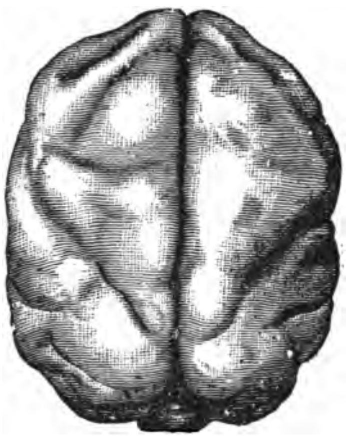


FIGURE 58.—Brain of a Monkey.

Size of the Brain.—It is not the animal whose brain is the largest and the heaviest that is the most intelligent. It is rather the animal whose brain is most convoluted,—most wrinkled,—and the one in which these wrinkles are the deepest and the largest, that has the highest order of intelligence, because in such a brain there is more brain surface and more gray matter rich in cells to do the work that the brain must perform. A brain with a great many wrinkles has more surface than one of the same size with fewer convolutions. Look at the picture of the brain of Gauss, the celebrated mathematician. (Figure 59.) Your teacher will tell you what wonderful mental ability this great scholar possessed. Notice how many convolutions and how deep they are. Such a brain has an unusually large surface, and therefore an unusually large amount of gray matter filled with nerve cells, and is a better brain than one with less surface, less gray matter, and fewer cells.

While it is true that some of the greatest scholars the world has ever known had large brains, it is also true that the largest brains known have been those of insane persons. I have before me now on my table as I write, the brain of an insane man and the brain of a highly educated young woman. The brain of the insane man is much larger and heavier than the other, but no one would think of saying that he was more intelligent. The woman, with her fine brain and its many convolutions,

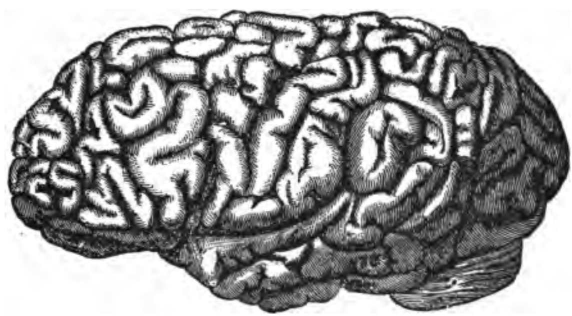


FIGURE 59.—Brain of Gauss, the celebrated mathematician and astronomer. (Vogt.)

was a celebrated artist. The man had been idiotic almost from birth, had always had criminal tendencies, had never been able to read or write, and was violently insane during the last years of his life. The woman's brain, while smaller, has more and deeper wrinkles, more brain surface, and more gray matter. That of the man, while larger, has fewer and more shallow fissures, less brain surface, and less gray matter. The woman was very intelligent and well educated. Her brain was developed. The man was always stupid and could not be educated. His brain was not developed.

The Divisions of the Brain.—The brain consists of three parts or main divisions. (1). The large brain, or *cerebrum;* (2) the small brain or *cerebellum;* (3) the spinal bulb, or *medulla oblongata.*

The *cerebrum* is the largest division of the brain, being about four-fifths of the whole. It is divided into halves or hemispheres. The gray matter here, as in the rest of the brain, lies

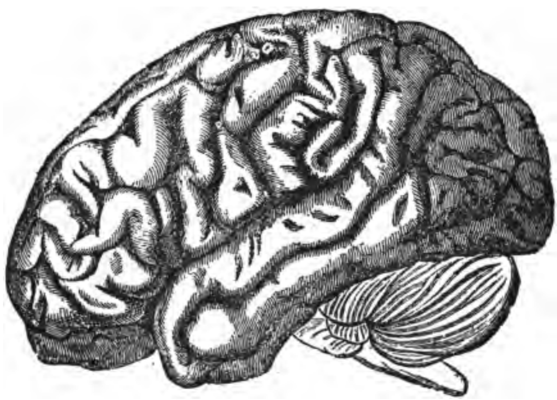


FIGURE 60.—Brain of a Hottentot.

on the outside, and forms a gray rind from one-twelfth to one-eighth of an inch in thickness, according to the degree of development or education. The thicker this gray outside layer,—that is, the more gray matter,—the better is the person educated. The *cerebellum* lies under the back part of the large brain and is joined to it. It also has the gray matter on the outside and many fine little fissures, giving the cerebellum, when cut through, a leaf-like appearance, called *arbor vitæ.*

The *spinal bulb* is the smallest division of the brain, being only an inch and a quarter long and about an inch in thickness at its largest part. It connects the rest of the brain with the spinal cord.

The Work of the Cerebrum—Receives Sensory Messages.— The various parts of the body are continually sending news to

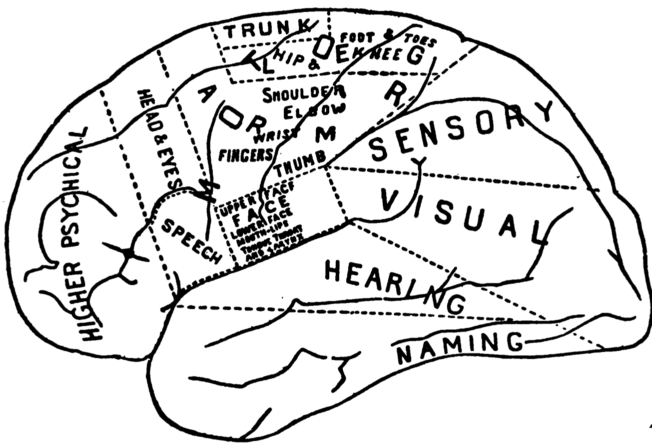


FIGURE 61.—Showing the various Brain centers.

the cerebrum, telling what is affecting them from without. Thus the nerves of the eye take messages of things seen. The nerves of the ear of things heard. The finger tips contain fine nerve endings that can feel acutely, and by them touch messages are sent to the brain. We get the news of the outside world by means of such experiences as seeing, hearing, touching, smelling, tasting, and the like. These different kinds of news gatherers and news carriers are called the senses. All

the messages that come through the eye are carried to the lower portion of the back part of the brain. This is called the visual center. Any activity of the brain cells within the center of vision, no matter to what such activity is due, gives rise to sensations of vision. Thus, even with the eyes closed, if you fall striking the back part of your head, you "see stars." This is because the jar has affected the back part of the brain, which is most active when we see things, much more so than any other portion of the brain. If disease should attack this part of the brain it would result in total blindness, even if there were nothing the matter with the eyes. Messages of hearing are delivered to the portion of the brain just above the ears. If this brain center is injured we become deaf, though our ears remain perfect.

Sends out Motor Messages.—Besides receiving messages, the gray matter of the cerebrum, or large brain, directs the motions of our bodies and their parts. The portion of the brain lying just beneath the top of the head and toward the front of the ears, sends out all the orders for motion, whether it be playing the piano, using the typewriter (see finger center), or directing the muscles of the face, arms, legs, or those finer muscles employed in speech. Speech is one of the highest acts of the mind. The lips, tongue, and vocal cords obey the brain cells of the "speech" center. If this part of the brain were injured, we would lose the power of speech. Sometimes a clot of blood forms in the little fold or wrinkle at the speech center, and in such a case the person cannot say the simplest words, such as "yes" and "no," until a piece of the skull bone over the speech center is removed and the little hard clot of blood washed

away. Such a person can still make noises with his mouth, but cannot talk; he can understand what is said to him, for the sense of hearing is not affected; he can write, for the brain center that directs the motion of the fingers is still in good order.

Some time ago, while in Germany, my attention was called to a very interesting case of loss of speech in one of the hospitals of Berlin. A German army officer had been thrown from his horse during one of the military parades which took place in the celebration of the anniversary of the battle of Sedan. In falling, his head struck the hard street pavement. At first he was unconscious. Soon after his return to consciousness it was discovered he could not utter a single word. Every attempt to speak resulted in dismal failure. Nothing came of his painful trials but a series of meaningless sounds. After five weeks an examination of the brain itself was determined upon, and it was found that the trouble was due to an injury to the speech center itself. A small portion of the skull being removed, a little hardened clot of blood was found directly over the speech center (see figure on page 155). This blood clot was carefully removed and the wound sprayed with a jet of warm distilled water. Three weeks after this operation was performed, the patient had fully regained his ability to speak.

Education of the Whole Brain.—In order that all parts of the brain be developed, it is necessary that they all be exercised. When we see things, only one part of the brain is active, and only one part developed thereby—the visual center. The rest of the brain is practically idle. In hearing, another part of the brain is exercised. And so in case of each

kind of sense experience, only one portion of the brain gets any exercise and acquires the development that naturally results from this activity. In order to have the whole brain properly developed, every one of its parts must be exercised, otherwise some portions die of disuse and inactivity. To be really educated there must be education through the activity of all the senses. There must be training of all the muscles. Manual training is of great value, not only in teaching the use of tools, but in giving to us a development of certain portions of our brains that would otherwise die from disuse. You know how flabby our muscles become, and how they finally atrophy, if they are not exercised. The same thing occurs in the case of the nerve cells of the brain. Those that are not exercised die and can never be created again. If they drop out, none ever take their place.

Each study in school is for the purpose of giving us a certain kind of mental training, a particular kind of brain exercise. Arithmetic gives us brain training with reference to memory, while nature study helps us in training the powers of observation. The boy who lives on a farm develops good observing powers, because he spends so much time out of doors that he is continually seeing interesting things. Many children in the crowded tenement houses of the city have never seen a bee, squirrel, or chicken, and do not know that leathern things come from the skins of animals, wooden things from trees, or milk from cows. They do not even know that meat comes from animals. Such children have their powers of observation blunted because they are shut in and unable to see things that the more fortunate boy in the country, and smaller towns and cities, can

see. The child who has no chance to observe is cheated, and can never be educated in the same broad way and to the same degree that he could were he more fortunately surrounded.

Every study in the school, every activity in work or play, can accomplish some special object along the line of mental training and brain development. For this reason we sometimes study subjects we do not like very well, because no other study could give us the same kind of mental exercise.

Work of the Cerebellum.—The little brain, or cerebellum, is of great service in helping us to balance the body in walking or standing. If it is diseased or injured we become dizzy and cannot walk straight. The reason a drunken man staggers and is unable to walk properly is because the alcohol he has taken makes the blood gather or "congest" over the cerebellum. This pressure of poisoned blood prevents the balancing center from acting perfectly. If a bird has its cerebellum injured, it cannot fly, but will flutter its wings in an aimless manner.

Work of the Spinal Bulb.—The spinal bulb, or medulla, not only serves as a means of conveying messages between the brain and spinal cord, but it is the seat or center of control of some important self-acting, or involuntary, muscles. The center of breathing is in the spinal bulb. If this little part of the spinal bulb be injured, breathing stops, and the person dies instantly. For this reason this place is called the "vital knot." The spinal bulb is also the seat of the centers of sneezing and swallowing.

The Brain is a Center.—You can now see why the brain is called a center. It directs all the important muscular activities. It is the central station to which all the sense messages about

things outside of our bodies are telegraphed. It is the physical basis of all our mental activities. Without the brain we could not see, hear, or have any sense experience. We could not remember or imagine things. We could never feel pleasure, we could never talk to our friends, we could not even love our parents. We could not direct, control, or educate the muscles, were it not for the brain. How important it is, then, for us to keep it in a healthy condition.

The Spinal Cord.—The spinal cord is the great "trunk line," made up by joining in one bundle the nerves from all parts of the body that go to and from the brain. It is a long tube of nervous matter and extends through the whole length of the spinal canal in the backbone. It is, therefore, from fifteen to eighteen inches in length in the adult. Differing from the brain, in the spinal cord the white matter is on the outside, and the gray matter is within. The cord contains both nerve fibers and nerve cells. This makes it possible for it to do both kinds of work. It not only carries the commands of the brain, but it does some work itself because of the cells it possesses. (1) It is a pathway to and from the brain, carrying sense impressions to the brain and motor impulses from the brain to the muscles. (2) It performs some activities without the brain's help, and thus saves the brain a large amount of work, especially in the lower animals. A frog with its head cut off can perform some movements quite well. A bug known as the Praying Mantis, will continue to fight its opponent a long time after its head has been severed. It does not need its brain to fight, the spinal cord is enough.

The spinal cord also contains nerve centers that tell the

cells throughout the body when to eat and grow, and inform the arteries how much blood to send to each cell. We put the food into the body, it is taken up by the blood, and the spinal cord tells the tissues when and where to use the food. It is the center of the *sympathetic* system of nerves. We have no control over the action of the spinal cord. We cannot feel it acting and we cannot keep it from acting. The spinal cord performs its important work without our being compelled to think about it. It acts when we are asleep as well as when we are awake.

Nerve Fibers.—You have perhaps already observed that there are two kinds of nerve fibers. (1) Those that carry messages from the sense-organs, like the eye, ear, and skin, to the brain, and (2) those that carry messages from the brain to the different parts of the body, directing them in their work. Thus the mind through the brain, and the brain through the busy little telegraph wires, or nerve fibers, receives word when the skin is cold, when it is in pain, as from a sharp pin, when it is burned, as with a hot iron, when it is tickled, as with a straw or feather. Likewise when the beautifully colored red rose or the delicately tinted sunset attracts the eye, a great number of little nerve fibers carry the message to the visual center at the back part of the brain, and the delightful object is perceived by the mind. In a similar way the pleasant taste of fruits, the bitter taste of medicines, the agreeable odor of the fragrant flower, and the delightful strains of music, arise from impressions on the sense-organs. These impressions are at once hurried to the brain for the mind to perceive, remember, and think about.

In a similar way, when the mind decides to do anything, the brain sends the message to the muscles best fitted to do the work. If we are going to draw a beautiful picture, the message is sent to the fingers, and not to the toes. If we are right-handed, this message is sent to the right hand, and not to the left. If we are going to sing, the message is sent to the vocal cords that they stretch just tightly enough to make the proper note. If we decide to study hard, the brain rivets our eyes on our books, and we do not see what is going on around us. We give attention to the teacher; that is, our mind decides to hear the teacher's explanation of a problem, and we do not hear the noises outside of the schoolhouse, but only what the teacher says.

Speed of the Nerve Messages.—The nerves act with great quickness. When we sometimes wish to say that something acts very quickly, we say that it is "as quick as thought." Yet there are some things that travel faster than we can think. Light, electricity, and even sound travel faster than the telegraphic messages from the eye, ear, or skin to the brain. The nerve messages from the ear travel faster than those of any of the other senses, even faster than the nerve messages from the eye. The slowest nerve messages are those that carry impressions of pain to the brain. They travel at the rate of twenty-six feet per second, while the fastest messages of hearing go at the rate of two hundred and fifty feet per second. The average speed of the nerve messages, taking all kinds into consideration, is one hundred and ten feet per second. If our hand is burned by contact with a hot iron, we first have an impression of touch, then heat, and last of all, pain, received by the

brain, for sensations of touch travel faster than those of heat, and of heat faster than those of pain.

School Headaches.—The brain sympathizes with all the other parts of the body. If the stomach and other organs of the body do not work properly, the brain sympathizes with them, and we have a sick headache. If we are not breathing pure air, or if the schoolroom is too warm and close, and we are compelled to breathe the same air over and over again, because of poor ventilation, we first become so dull and sleepy that we can hardly study, and finally we have a severe headache. If we fail to take exercise to make our blood circulate well, we suffer from headaches.

Kinds of Headaches and Their Causes.—Children should never have headaches; but they frequently suffer from them because of irregularities, carelessness, and ignorance on their own part with respect to such things as proper food, exercise, amount of sleep, and ventilation. They come as warnings that certain conditions are wrong and must be changed to prevent long and serious illness. Mother Nature kindly warns us by means of headaches whether we are abusing our bodies or living in the right manner.

Headaches Due to Poor and Insufficient Blood.—These headaches occur very frequently in children between the ages of eight and fifteen years. They generally occur at the top of the head, sometimes in the forehead, and consist of a dull, boring pain, usually most severe early in the morning. These headaches are usually accompanied with a slight dizziness and feeling of faintness. In a person suffering from this kind of headache there is a paleness of the gums and roof of the

mouth, showing that there it not enough rich blood to nourish the body properly. Blood-making foods should be eaten, and blood-circulating exercise should be taken. These two things will do more to insure health and freedom from this kind of headache than all the drugs in the world. Milk, eggs, beef, mutton, and such nourishing foods should be eaten. Rich foods, such as pastry, should be given up entirely. Meals should occur at

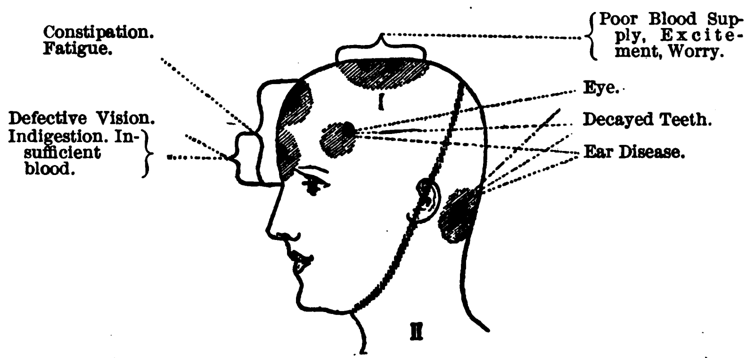


FIGURE 62.—Showing location of Headaches, according to their causes.

regular hours. Exercise should be taken every day to the extent of creating an appetite and assisting digestion.

Headaches Due to Indigestion.—These headaches are common to children of all ages, and are due to errors in eating. They are generally located in the forehead. They come on suddenly and continue until their cause is removed. They are easily recognized by the fetid breath, the coated tongue, distress in the stomach, and constipation or diarrhœa. I have known them to arise in many cases from the habit of eating cold lunches, and from eating too rapidly.

Headaches Due to Ear Disease.—These headaches are extremely painful, and are usually located just back of the ear. Even a gentle touch at this locality makes the pain unbearable. These headaches are due to the formation of pus, as often occurs after such diseases as scarlet fever.

Headaches Due to Eye Strain.—These headaches occur in children who either have eye defects or who study and read in poorly lighted rooms. If light is reflected on the blackboard so as to dazzle the eyes, or if the writing on the blackboard is too small to be read easily, or if the child is "far-sighted" or "near-sighted," such headaches are very likely to occur. Reading print that is too fine, or too large, on poor paper, with poor light, will also cause these headaches. They are quite similar to other "nervous" headaches. The pain is located either at the back part of the head or at the temples above and back of the eye. Excitement will also cause nervous headaches, as will mental fatigue due to overstrain in school work.

Headaches from Fatigue Poison.—Fatigue is a poison. When we are fatigued by work and worry there is a poison present in the blood just as truly as there is in typhoid fever, diphtheria, and other infectious diseases. If the blood is poisoned by fatigue as a result of mental overstrain, the brain is first affected. The brain using much more blood in proportion to its size than do the other parts of the body, suffers most if the blood is poisoned from fatigue or any other cause. When one is out of his head, or delirious, during a raging fever, it is because of the poisons in the blood due to the rapid burning of bodily tissue. The brain must continually have a new supply of blood. The brain cells are continually starving

for oxygen. If the corpuscles bring poison instead of oxygen, the brain cells feed on poison. They suffer from this, and cannot do their work honestly. They cannot be depended upon.

The headache resulting from fatigue is a dull, burning, heavy pain (not a sharp, shooting pain) in the front part of the head. It is a warning for us to lay aside work and worry for a little while, and take brisk exercise in the open air.

Other headaches to which children are subject are those present at the beginning of such illnesses as typhoid fever, scarlet fever, and diphtheria. Children suffer from headaches that result from malaria (especially in some of the Southern States and in other "ague" districts). Any poison in the system will produce a headache. I know of a case where a little girl suffered from headache nearly every day. Every effort was made to find the cause, but without success, until it was noticed that she was in the habit of buying a certain kind of chewing-gum wrapped in tinfoil. The lead in the tinfoil came in contact with the gum, and produced lead-poisoning. When she gave up this habit, she no longer had the headache.

Rest.—The brain, as well as the rest of the body, would soon fail to do good work if compelled to work too long or too hard. Rest is necessary for all parts of the body. It is especially necessary for the brain. The best form of rest is change of the kind of work rather than absolute idleness. The hardest kind of work for a child is to sit or stand perfectly still. Idleness is not rest. If the mind is tired, the best thing in the way of rest is some brisk physical exercise. This is the reason we have recesses in our schools. Recesses should not be spent in the schoolroom, but should be used as an opportunity for

free play and outdoor exercise for both boys and girls. Young children in the first two or three grades should have more recesses, even if they are shorter, than older pupils. Exercise brings a new supply of blood to the brain, and gives it new life, making the mental work of study and recitation much easier.

We do not spend an entire day in the study of one subject in our schools. Why would it not be a good arrangement to study and recite arithmetic all day Monday, language lessons all day Tuesday, spelling all day Wednesday, and so on? We all know that such a school program would be ruinous. There would be none of that delightful mental rest that comes with change of subjects after short intervals. We would be so tired of one subject before the day was over that we could no longer give attention to it, and could not drive our minds and brains to do any more work. The brain in such a case would be no longer able to digest the facts pertaining to this one subject. It would be like the stomach of the man who agreed to eat one quail a day for thirty days. Brain and mind rest comes best with frequent changes of program. The recitation and study periods of any one subject should not be so long as to make our brains weary of that subject, giving us a feeling of mental fatigue and disgust so far as that particular study is concerned. Not only should the study and recitation period of each subject be comparatively short, but each subject should be followed by one that is a complete change, that is, one that calls into activity other portions of the brain, and gives rise to mental operations quite different from the ones that have been going on. Thus arithmetic should be followed by such a sub-

ject as reading, and reading by elementary science or nature study—a complete change, therefore, a rest.

Sleep.—Sleep is the only form of complete and general rest. During sleep a less amount of blood flows over the brain surface, and there is rest from activity quite similar to that of trees that hibernate or sleep in winter, when the sap goes down from the branches to the roots. If a boy or girl eats and sleeps well and regularly, securing a sufficient amount of sleep every twenty-four hours, it can scarcely be said that his brain is overworked.

In some of the large cities, such as London, New York and Chicago, recent investigations have shown that hundreds of poor boys are compelled to work forty hours each week, in addition to the time spent in school, at such employment as selling newspapers, delivering milk, and running errands. Many of these boys are compelled to begin their outside work at three o'clock in the morning, and carry on their school work under great strain. During the afternoon session they often become so sleepy, as the result of nature's demand for rest, that they cannot do good school work.

The average amount of sleep required at—

4 years of age is 12 hours,
7 years of age is 11 hours,
9 years of age is 10 1-2 hours,
10–12 years of age is 10 hours,
12–14 years of age is 9 hours.

If there is any great departure from these averages the child is not in normal health. Disturbances of digestion are often the cause of sleeplessness. Poorly ventilated and over-

heated rooms also cause restlessness and disturbed sleep. A window in one's bedroom should be kept at least partially open during the entire night. Children under fourteen should be allowed a little more sleep in winter than in summer, and when they are growing most rapidly. It is a deplorable fact that very young and growing boys and girls are, especially in winter, taken to concerts and other evening entertainments. It is not surprising that they come to school the next day tired, when they should be rested, the fatigue showing in the bagginess of the eyelids and the dark circles around the eyes. Coming to school in this unrested condition, they are unfit for the best mental work.

Children should never go to bed hungry. When hungry, one cannot go to sleep readily, nor sleep so soundly. Instead of going to bed hungry, one should partake of some easily digested food, such as bread and milk, crackers, or even a glass of milk without anything else. Good milk, you remember, is a perfect food, and besides it promotes, rather than retards, sleep. Overwork, over-excitement, or the reading of horrible or exciting tales just before bedtime, also constitute a frequent cause of serious disturbance of sleep. Trouble and worry likewise are sleep-robbers.

During sleep the brain cells regain their strength. Sleep does most good when it is regular. A person gets the most benefit from sleep if he goes to bed at about the same hour each evening. The beneficial rest of mind and body that comes so naturally and completely with sleep cannot be secured in any other way. All animals that have well-developed and highly organized nervous systems must take rest in sleep.

Dreams.—Sometimes when the rest of the brain is asleep, a few of its cells for some reason keep acting. They act in so lively a manner as to leave memories when we awake, as if they were real occurrences. These activities of a few brain cells during sleep constitute our dreams. We dream most impossible things at times, which goes to show that only a few cells have been active. When more are active, as when we are awake, our ideas are clearer, for then the cells act more honestly, and correct each other.

Habit.—I know an old man who, for twenty years, had been what is known to railroad men as the "night caller," his work being to call those engineers and firemen who were obliged to run the night trains. Reaching an advanced age, after such a long term of faithful service, the railroad superintendent decided to give him more pleasant employment. Instead of being compelled to work the entire night, exposed to all sorts of weather, he was offered a position which would pay him a little better salary, and at the same time exact shorter hours of labor, which, best of all, would be in the daytime. At first the old man gratefully accepted, and entered gladly upon the new work. After a few days he became dissatisfied with this new and better position, and this dissatisfaction so grew upon him that in a short time he came to the railroad official and begged that he might be permitted to go back to his old-time night work, even at a less salary than he was then receiving. That is, he was desirous of exchanging what ordinarily would be termed comfort for discomfort, only because he had worked so long at night that he could not feel satisfied with other work. He had learned to sleep better in

the daytime than at night, and his whole life had become the reverse of that followed by the majority of men. Men who have grown old in prison have asked to be readmitted after having served their sentences, and on this request being denied, they have committed some crime that involved their being sent to prison again. People like to do things as they have always done them—like to live as they have always lived.

If the brain cells have acted in the same way a few times, they tend to act in exactly the same way again. When you bend your arm, your coat or dress sleeve wrinkles in exactly the same manner each succeeding time. When a piece of paper is once folded, it folds more easily in the same place the second time. A door-lock works better after having been frequently used. A piece of machinery works more easily, there is less resistance, after it has been run some little time. Our brain cells are subject to the same rule. Certain brain cells that act together once, act together more readily a second time, still more readily the third time, and so on. They form the *habit* of acting together. If our brain cells in the speech center act in such a way as to make us say, "I done it," for "I did it," or any other grammatical error, it is easier for them to act together the second time and cause us to make the same mistake. The more they act together in using wrong language or profane words, the harder it will be to overcome this habit. Our nervous system, our brain cells, may become our strongest ally, or our worst enemy, according to the habits formed. If the proper brain cells have acted together from the first, then good habits are formed that help us at every stage of our existence. How important, then, that we begin right, in order

that our nervous system may form habits of helping rather than hindering us. We must acquire habits. We cannot help acquiring them. Shall they be good or bad?

Character.—The habits acquired determine character. All of our habits of life and action, whether mental or physical, have some sort of basis in the physical organization and training of our bodies. The first command, in the form of a nervous impulse, carried from the brain to certain groups of muscles in order to cause some definite form of activity picks its way, as it were, in order to find the path of least resistance. The next impulse from the brain to bring about similar muscular activity will follow this path that has already been used. In the course of time this nerve pathway becomes so well marked, so deeply cut that it is a "fixed habit" of action. We all know how difficult it is to change a fixed habit.

Groups of nerve cells that have once acted together tend to act together again. The more they are associated in their activity, the more easily and readily do they act on each succeeding occasion. Have you not observed that a person in learning to play the piano must closely attend to every movement of the fingers, but after long practice his fingers seem to strike the proper keys without any special effort or direction? Certain of the brain cells have become so accustomed to work together in the long periods of practice, that they act almost of their own accord, accurately and quickly, just as soon as the eye in glancing at the sheet of music perceives the note that should be sounded, and sends this message to the brain. Habitual

actions are always performed with less effort, in less time, and more accurately than new activities could possibly be.

Our nervous systems become accustomed to certain ways of living, and certain modes of activity. The paths connecting the brain cells concerned in these frequent activities, are the easiest ones for the brain impulses to employ. The more one coasts down the snowy hillside, the smoother does the path become, and the faster and farther does his sled travel. The more one does a certain thing, the more likely is he to do it again. This is illustrated in every one of our habits. If these habits are good, our nervous system is our ally, and it is comparatively easy for us to do what is good. We do not have to struggle and battle against habitual tendencies; instead, our habits help us. If these habits are wrong, then they are as a millstone round our necks in our efforts at correct living.

This principle of habit applies in every particular to the practice of using alcoholic beverages. Each succeeding time the taste for drink is indulged, the less does one's power of resistance become. The real meaning of the word "habit" is "that which holds us," and when a form of action becomes a habit, we are held in firm grasp. Let me illustrate. A college mate of mine, a fine-appearing young man belonging to one of the leading families in this nation, had been in the habit of taking a social glass of liquor. From some cause he became seriously ill, and his mother, who was traveling in Europe, was cabled for. By the time she crossed the Atlantic to be at her boy's bedside, he became stronger and almost well, and with the thought of surprising his mother and allaying her anxiety, he planned to go to New York and meet her at the steamer on

its arrival. During the ten days of his illness he had not tasted any sort of liquor, because of the doctor's orders. In going from the college to the railway station, enjoying the delightful morning air, his path led by a saloon. He was warned by his physician to never again partake of alcoholic drinks. He was determined to obey this injunction, but as he was passing the saloon door his whole nervous system seemed to cry out for drink, and weakened as he was because of his period of illness, he could not resist. He entered the saloon, drank the liquor, and this brought on a relapse of the fever, from which he died—*because, through habit, his nervous system was his enemy rather than his ally.*

Healthy Brain Requires Healthy Body.—The brain cells are the first to suffer if the blood is not pure, if the air is bad, if the food does not digest, or if anything else interferes with our bodily health. The best brain work comes easiest to the person having a healthy body. Proper physical exercise is of great value in brain health and brain training. A sound mind in a sound body should be the result of all education on the part of the school, the home, and the individual himself.

EXERCISES.

1. Debate in class: "Is the dog or the horse the more intelligent animal?"
2. Write, in the form of a composition, an account of a dream you have had.
3. Give a written account of the earliest event in your life, which you now remember as having occurred, stating your age at the time of its occurrence.

CHAPTER XI.

THE EYES AND THEIR CARE.

Our bodies are truly wonderful. Perhaps the most wonderful and delicate organ of the human body is the eye. Have you ever thought what great care nature has taken to protect the eye? It is set deep in a bony socket, the edges of which serve as a strong guarding ring; the eyebrows overhang it so as to keep water or perspiration on the forehead above from running into the eye; the eyelids are fringed with lashes, and serve as curtains, closing over the eye instantly when the light is too strong. In the same manner the eyelids protect the eyeball from dust and dirt. The nose also helps to protect the eye from blows or jars from the front or side. That the eye, so necessary to comfort and success in life, is highly prized by Mother Nature, is shown by the safeguards and means of protection provided. Much of the health and care of our eyes, however, depends entirely upon ourselves. If we mistreat them we are sure to suffer in many ways. Much carelessness with respect to the use of our eyes will cause harm that can never be remedied.

Description of the Eye.—The eye is a globe filled with a clear fluid. It has three coats or layers. The outer one (*sclerotic*) is white, and this is what is called the white of the eye. The second layer (*choroid*) is black, so as to absorb sur-

plus light, that the object looked at may be clearly seen. It serves the same purpose that the black lining of a photographer's camera does. When the photographer takes a picture, he covers his head and the camera into which he is looking with a black cloth to shut out surplus light. The only light he desires to enter his camera is that which comes direct from the object, the picture of which he is taking. The inner coat, or third layer, is a thin membrane called the *retina*. It is made up of many nerve cells, and is the sensitive plate of the eye on which all images of objects must be received before the objects themselves can be seen.

At the front of the eye is a clear, round window, called the *cornea*. Back of this is the *iris*, a round, muscular curtain, with a small, round, black hole in it, called the *pupil*. The iris is blue, brown, gray, or black, and gives to the eye its color. The pupil becomes larger or smaller so as to regulate the amount of light that enters the eye. In very bright light it becomes quite small so as to shut out many of the rays. In dim light it becomes very large so as to permit all the light possible to enter the eye. Have you not observed that after you are in the dark for a few minutes you can see better than when you at first entered the darkness? This is because the pupil of the eye requires a little time to expand, and thus adjust itself so as to receive as much light as possible. When you enter a brightly lighted room, after you have been in the darkness, objects seem blurred. You cannot see things clearly because too much light enters the eye, and the pupil must become smaller (which it does in an instant) before the

eye can have a clear picture on its retina. Why can a cat see much better in the dark than a person?

Behind the pupil is a flattened, double-curved body with layers like an onion, called the *lens*. It is like a magnifying glass, in bringing all the rays of light together into one bright

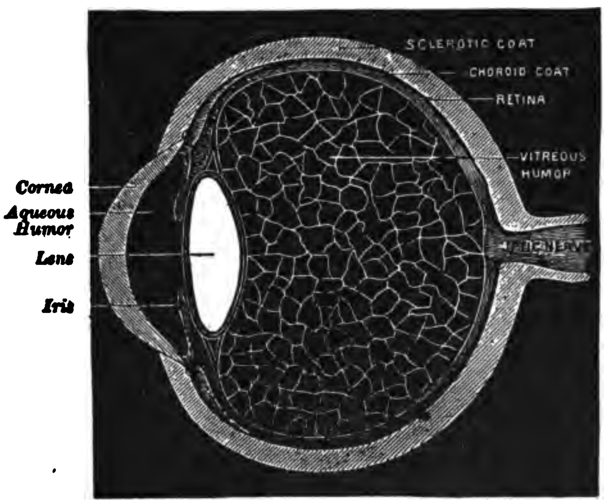


FIGURE 68.—Section through the Eyeball.

spot. The lens of the eye gathers together the rays of light, just as does the lens of a magic lantern in order to throw a clear picture on a screen. In the eye the sensitive retina is the screen, and the optic nerve carries the impression of this picture to the visual center at the back part of the brain, and thus produces vision. The *vitreous humor* is a colorless fluid, like the white of a raw egg, filling the large portion

of the eyeball back of the iris and lens. The *aqueous humor* is a similar but somewhat thinner liquid, filling the small portion of the eyeball between the cornea and the lens.

How We See.—The light reflected from the object enters the front of the eye at the cornea, passes through the aqueous humor, the pupil, the lens, the vitreous humor, and throws a picture of the object, upside down, on the screen called the retina, and this is connected with the visual center at the back part of the brain by means of the optic nerve. When this impulse, or impression, reaches the brain, we see. If the optic nerve is cut, or dies from disease, we become blind, not because our eyes are no longer good, but because their connection with the brain is destroyed. Sometimes a *cataract* grows over the cornea, or pupil, at the front of the eye, and shuts out all light so that we cannot see. This is a frequent cause of blindness. But nowadays the surgeon does his work so delicately that the cataract or diseased coating can be scraped off, like a blot of ink in your copybook, or a hole can be scraped through it and sight is restored. Much blindness is caused by improper care of the eyes, and many such cases can now be cured because of the wonderful skill of the modern surgeon.

The Eyes Move.—Each of the eyes can be turned in any direction by means of six muscles. This arrangement enables us to watch objects from every point of view. By means of these muscles, we can rapidly glance up, down, to the right, to the left, or roll the eyes about. The muscles usually guide both eyes together, just as we guide a team of horses with the reins. In the eyes, however, there are six pairs of reins.

Being Cross-eyed.—Sometimes one or more of the muscles

is not of the right length, and both eyes will not be guided alike. One eye will then look at one object, while the other looks at something else. Such a person is *cross-eyed.* By means of an operation the offending muscle can be shortened or lengthened, and the cross-eyed person is cured. The operation is most successful when it occurs in childhood.

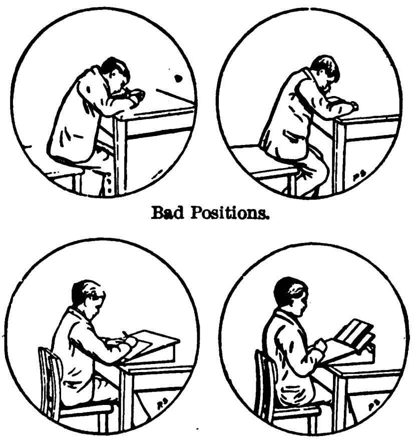
Tears.—While we are awake the eyes are in almost constant motion. To prevent friction from rubbing against the lids, as well as to wash out little dust particles, and thus prevent injury, each eye is moistened by a saltish liquid, called *tears.* These tears are secreted in a gland above and toward the outside of each eye. Each gland is about the size of an ordinary bean, and is connected with the inside of the nose by means of a small tube. When one weeps, or cries, the tears run faster than this tube or duct can carry them into the nose. Then they run down the cheeks. Tears are useful in keeping the eyeballs clean.

Near-sightedness.—You may have observed that some persons, to see clearly, must hold the book, newspaper, or other object being looked at, close to their eyes. This is called near-sightedness. Near-sighted pupils are apt to lean over their desks, causing round shoulders. Others make themselves near-sighted through the habit of sitting in a stooped-over position, as in the bad positions shown in the accompanying picture.

Far-sightedness.—Other persons cannot see objects close to them as well as they can those at a distance. This is called *far-sightedness.*

Spectacles.—All persons with defective vision, whether suffering from near or far-sightedness, should wear well-fitted

spectacles, which will make it possible for them to see as well as any other person, and without discomfort. In far-sightedness they must wear spectacles with lenses of such curvature as to cause near objects to be seen clearly. In near-sightedness the lenses must, of course, be of just the opposite curvature.



Bad Positions.

Good Positions.
FIGURE 64.

After middle life, and as we become older, most of us will find our eyesight becoming defective. This is due generally to the little muscle controlling the shape of the lens. This muscle loses its power as age advances, and because of this the lens can no longer adapt itself so as to see objects at different distances. The eyes should be examined by a skilled oculist without delay, and suitable glasses should be used. This condition of defective vision should not be neglected. As the years advance, "stronger" glasses will be necessary.

The Blind Spot.—The place on the retina where the optic nerve enters the eye is totally blind. This spot has no nervous elements sensitive to light. To prove the existence of the blind spot, close the right eye and look steadily with the left at the cross in Fig. 65, holding the book directly in front of, and moving it to and from the face. At about one foot from the

face the black disk entirely disappears; when nearer than this or farther from the face, it is seen. In this simple experiment, it is absolutely necessary to keep the left eye focused on the cross. The blind spot is about one-thirteenth of an inch long in the average human eye.

Care of the Eyes.—Trouble with the eyes may arise from a number of causes. If the whole body is weak and the health poor, the eyes are also apt to be weak. Continued stomach trouble frequently causes serious and permanent eye trouble. Poor circulation of the blood always affects vision. One should

FIGURE 65.

never study or read early in the morning before breakfast, when the stomach is empty, for such a practice will quickly cause inflammation of the eyes. A cold causes serious discomfort with respect to vision in much the same way that it develops a sore throat, by inflammation of the delicate membrane lining it. After any serious illness, during convalescence, great care should be taken in the use of the eyes. Many diseases, such as scarlet fever, measles, and diphtheria, seriously weaken the eyes, so they cannot do the usual amount of work until there is perfect restoration to health. Pale ink, greasy slates, dirty blackboards, and hard lead pencils that do not make a black mark, are very trying to the eyes.

Eyesight and School Work Directions to Pupils.

1. Sit upright, sit square.
2. Keep your eyes at least twelve inches from your work.
3. Write on a slope, not on a flat table.
4. Read with your book well up; do not lay it down flat.
5. Do not read very small print.
6. Do not work in a bad light.
7. If you cannot properly see your work, tell your teacher.

Out of School.

1. Do not read lying down.
2. Do not read by twilight, or by a poor light, or when the eyes are tired.
3. Do not face the light in reading.
4. Do not look steadily at the sun or a very bright light.
5. When your eyes feel tired after reading for a time, rest them by looking at objects at a distance.

Poor Print and the Eyes.—Badly printed school and other books read by children cause undue strain of the eyes. The type should be plain, clear, and sufficiently large. It should be Roman rather than Gothic. This book is printed in Roman-faced type, and of the proper size for school books. After a number of tests upon a great many children in the laboratory of one of our largest universities, it was found that the style and size of type used in this book is that which is most easily read by persons older than nine years. It is called Long Primer.

The following show the various sizes of type:

(Double Pica.)	(Great Primer.)	(Pica.)
The size	and style of	type used in

(Long Primer.)	(Bourgeois.)	(Minion.)	(Pearl.)
printing the pages of	this book is	more easily read	than any other.

None smaller than the one indicated as Long Primer should ever be used in school books. The largest type here shown is too large for any school book. Type that is too large is as injurious to the eyes in study, as type that is too small.

Impressions from old and worn-out type are apt to be imperfect. The long letters become broken or worn off at the ends, the a and e are not distinct, and the b and h, as well as the p, g, and q, are hard to distinguish. The lines should not be too close together, and should not be too long. A cream-tinted paper is easier on the eyes than pure white. Straw-colored manila paper is far better than white paper for pencil work by artificial light. School tablets made of manila paper are both cheaper and better for pencil work than white paper. A soft pencil should be used, as it will make a plainer mark.

Testing the Eyes.—A child with normal eyesight ought to be able to read the pages of this book in a good light at a distance of forty inches, and as close as six inches, and at all distances between these two. A child that cannot read it as far as from fourteen to sixteen inches from the face should have his eyes examined by an oculist. A rough test can be made with the following heavy black letters, looked at from the designated distances with each eye separately.

O F

Can you read these letters at the distance of forty feet?

P H E

Can you read these letters at the distance of thirty feet?

Z P L R D F

Can you read these letters at the distance of twenty feet?

A F E T B X V

Can you read these letters at the distance of fifteen feet?

V B S H O K N E D A

Can you read these letters at the distance of ten feet?

In thus testing your eyes place the open book in good light against the wall of the schoolroom. Test each eye separately. Keep both eyes open. Do not close the eye not being tested, but hold a card, a book, or your hand in front of it. Start at a distance of about fifty feet and walk *toward* the "test-type" letters, keeping your eye fixed steadily

on them. If your eyes are as good as they should be, you will discover that you can distinguish the two largest letters at a distance of forty feet. Then walk still closer, and note carefully at what distance you can read each of the other rows of letters. Observe whether your right eye is stronger or weaker than your left eye. These tests will be exact enough to reveal whether or not your eyes are normal. If they are not, you may find in this fact the true reason for headaches, from which you may suffer at times. In case your eyes are defective, it is always a good plan to consult an oculist. Defects of vision are always more readily cured when one is young. You can safely use your eyes until they begin to ache or burn. They should never cause pain from use. If they do, something is wrong. At the first sign of such discomfort, it is best to stop work and give the eyes a rest.

QUESTIONS FOR STUDY.

1. How do birds compare with other animals in keenness of vision?
2. What is meant by such expressions as "watch like a hawk," "eagle-eye," and the like?

EXERCISE.

Write an account of what is meant by color-blindness.

CHAPTER XII.

THE HYGIENE OF THE EAR.

The ear is almost as delicate and fully as interesting as the eye. It is even more complicated. Before considering the care of this important and wonderful instrument, we will briefly observe its structure.

Each ear is made up of three distinct parts: the external ear, the middle ear, and the inner ear.

The External Ear.—The outer ear is simply a funnel to catch sounds, which are carried through the middle ear to the inner ear. It consists of the part which is seen standing out prominently on either side of the head, and also the auditory canal, extending as far as the drum of the middle ear. The auditory canal is nearly one inch in length. You have seen a person partially deaf curve his hand about his ear so as to make this shell-shaped funnel larger, and thus catch more sound. In some animals the outer ear is movable and can therefore be adjusted to make the sense of hearing more acute. Have you not observed how dogs and horses prick up their ears when trying to listen closely to an unfamiliar sound? The *concha,* or shell-shaped funnel of the external ear, consists of thin, corrugated pieces of cartilage, covered with skin on both sides.

Ear Wax.—The auditory canal is lined with a continuation of the skin on the inner surface of the concha. Within the

canal, this lining contains glands that secrete a fluid with which to moisten and protect the parts, especially the ear-drum. This fluid is bitter, and prevents insects from crawling very far into the ear. It catches any dust or dirt that might otherwise enter too far into the auditory canal. You will notice that this canal is curved. You cannot see as far as the ear-drum when looking inward because of this curve. A cinder, flying insect, or other harmful object, is thus less apt to injure the ear-drum than if there were a straight channel from the outside. When the fluid that is exuded by the lining of the auditory canal hardens, it becomes wax. You should never use a sharp instrument in removing this, as there is grave danger of injuring the lining, causing serious inflammation, similar to the inflammation that exists when one is suffering from earache.

The Ear-Drum.—There is a thin membrane forming a wall across the end of the auditory canal, making the boundary between the external and middle ear. This membrane, together with the tissues to which it is attached, is called the ear-drum. The drum-head, the thin, delicate partition to which we have just alluded, is readily set in vibration by the sound waves received from the external ear through the auditory canal. If it did not vibrate we could not hear, for the sound waves would not then be transmitted. The least puncture of the drum-head destroys its ability to vibrate in harmony with the sound waves received from without. It is essential that this delicate membrane be kept from injury of any sort.

The Middle Ear.—Just beyond the drum-head is the small cavity known as the middle ear. Stretched across this cavity is a chain of very small bones, which, from their shape, are

called the *hammer*, the *anvil*, and the *stirrup*. The handle of the hammer is attached to the inner surface of the drum-head, while its head forms a joint with the anvil. The anvil is also directly attached to the stirrup. At the bottom of the middle ear is a small tube, affording a passage from the upper and back

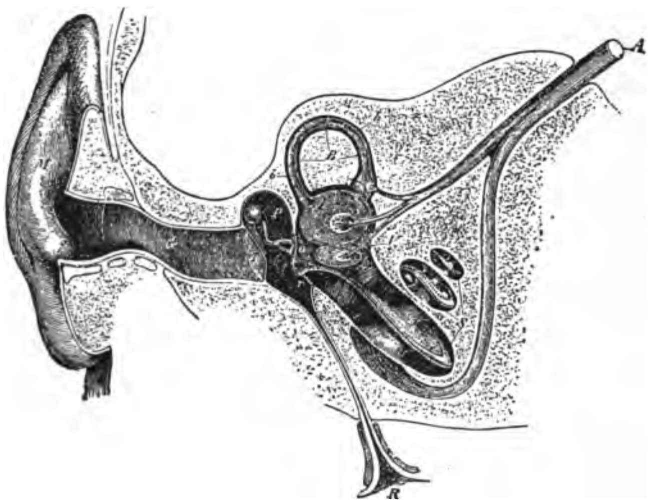


FIGURE 67.—Section through the Right Ear. M, Outer ear; G, Auditory canal; T, Drum-head; P, Middle ear; R, Eustachian tube; V, Vestibule; B, One of the semi-circular canals; S, Cochlea; A, Auditory nerve.

part of the throat. By means of this *eustachian* tube, for such it is called, a supply of air, so necessary to the health and perfect action of the middle ear, is kept up. The drum-head would sag inward if there were no air pressure from within the middle ear. This would prevent proper vibration, and seriously interfere with hearing. The adenoid growths described in Chapter IX.,

by clogging the eustachian tube, impair hearing. They are probably the most frequent cause of defective hearing in children.

The Inner Ear.—This is the most complex portion of the organ of hearing. It consists of three parts: the *vestibule*, a small chamber not larger than a grain of wheat, next to the middle ear; the *semicircular* canals joined to the vestibule, and the *cochlea* or snail-shell. The three semicircular canals in each ear are filled with fluid, and serve as spirit levels for the body. By means of them we quickly judge of the position of the body, especially the head. A person whose semicircular canals have been destroyed by disease can rarely be made dizzy, no matter how long his body is rotated. The cochlea is directly connected with the auditory nerve, and is the most important part of the ear, because it changes the sound waves into nervous impulses to be transmitted to the hearing center of the brain.

Some animals, as fish, have only an inner ear. The inner ear is the real organ of hearing. The external ear conducts sound to the middle ear. The drum of the middle ear, with the bones and eustachian tube, makes more clear and distinct the sound waves received from the outer ear.

Care of the Ears.—The essential parts of the ear being deeply seated in bone, are in less danger than the eyes, and do not so frequently suffer from injury. Still, the ears do become affected. Hearing is thus impaired, and even destroyed.

A very common danger results from carelessness on the part of some, especially young children, in introducing foreign bodies into the ear. Some children will thoughtlessly put the end of a penholder or pencil into the auditory canal. A piece of lead may break off and lodge against the drum-head. For-

eign bodies of this kind are by no means easily removed, and if their removal is attempted by an unskillful person, the drum-head may be punctured, causing irreparable injury. Water must be regarded as such a foreign body, liable to cause injury if it fills the auditory canal. For this reason, in diving and ducking when swimming, we should stop our ears with our fingers.

Temporary deafness may result from closing the auditory canal with a surplus collection of wax. If an attempt is made to remove this with a pin, toothpick, or other pointed instrument, there is great danger of injury to the drum. The best method is to drop a little sweet oil into the ear, and then with warm water syringe the canal until it is clean. If an insect should crawl into the ear, it can be killed with a couple of drops of sweet oil and afterward washed out. Insects that have entered the ear can sometimes be coaxed out by holding a light quite near the external opening. They are attracted by the light, and turn round and crawl toward it.

A blow on the ear is always dangerous, and may cause sudden and permanent deafness. The force of the air compressed into the auditory canal and against the drum may cause a bursting of the drum-head, though the blow itself would not be severe enough to cause much pain. Loud sounds, such as the firing of a cannon, sometimes cause deafness. As a rule, such deafness is only temporary. If the loud noises are frequent or continuous, permanent deafness may ensue. For this reason boiler-makers very often become deaf. Some drugs, such as quinine, make the ears ring. This disturbance is but temporary, lasting only a few hours, but may, after a time,

from excessive doses, develop into a permanent impairment of hearing.

Defective Hearing and Dullness.—Such diseases as scarlet fever and diphtheria frequently cause partial deafness in one or both ears. When this occurs in a very young child, it is not readily detected by others, and he grows so accustomed to his misfortune, that by the time he enters school he fails to realize that his hearing is less acute than that of other children. Or the same condition may result from adenoid growths closing the air-passage from the throat to the middle ear. He does not distinctly hear the questions or the explanations of the teacher, and is sometimes charged with inattention. For this reason it is well to have the hearing as well as the eyes of children tested on first entering school. Marked dullness of children in school work is generally the direct result of defective hearing.

QUESTIONS FOR DISCUSSION.

1. Which sense is the more important, vision or hearing? Why?
2. What other senses have we besides vision and hearing?
3. Which of our several senses is the first to go to sleep when we go to bed?
4. What is ventriloquism?

CHAPTER XIII.

THE TEETH AND THEIR CARE.

The teeth cut and grind the food and mix it with saliva. Their work in thus preparing the food for digestion in the stomach and intestines is very important, and should be thoroughly done. It is necessary that the teeth be protected and cared for.

The teeth are different from any other part of the body in that they cannot, of themselves, recover from injury. If the skin is torn, a muscle cut, a bone broken, repair at once begins; they eventually heal, and are soon practically as good as ever. An injury to a tooth is permanent. It has no power to mend itself, but is utterly unable to build over with new growth, as is the case with the other tissues of the body.

Not only do injured or decayed teeth cause pain, but they interfere with the general health in various ways. A person with decayed teeth cannot chew his food fine, if he would, and chewing with such teeth not only interferes with the later digestion, but of itself may cause pain. If it is painful to chew the food because of imperfect teeth, the person so affected soon forms the habit of bolting his food without proper mastication. Again, decayed teeth are often a source of poison to the blood, and in this manner may also jeopardize the general health of the individual.

Structure of the Teeth.—Each tooth has its *crown*, or top; its *fang*, or root, and the *neck*, or portion between the crown and the root. If we saw through a tooth vertically, it would be seen to consist of several distinct substances arranged in layers. In the interior is the pulp, a soft substance supplied with nerves and blood vessels. These nerves and blood vessels enter the tooth through a little hole at the tip of the root. If a nerve or the pulp be exposed to the air, pain or aching will result. *Dentine* is the name of the substance lying next to the pulp. At the crown it is covered with *enamel;* at the root, with *cement.* The dentine comprises the larger part of the tooth, and is a form of bone tissue, being composed of both mineral and animal matter. The brilliant white layer, or enamel, which covers the tooth at its crown, is the hardest substance of the body. The enamel is an armor-plate, protecting the exposed portion of the tooth from decay. A small hole or crack in the enamel is soon followed by decay of the dentine and pulp. The enamel must be sound in order to have healthy teeth.

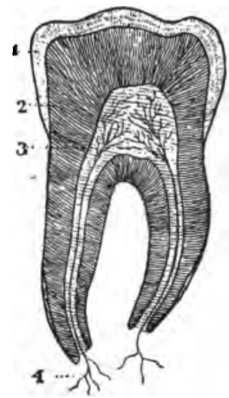


FIGURE 68.—Enlarged vertical section of a Tooth. 1. Enamel; 2. Dentine; 3. Pulp. 4. Blood vessels and nerves.

Kinds of Teeth.—The child begins to get his first set of teeth when about six months old, and soon has them all, twenty in number. Between the ages of six and thirteen, according to the state of his general health, the teeth of this temporary set begin to loosen, and are supplanted by a permanent set of twenty-eight teeth, half of which are in the upper and half in

the lower jaw. At the age of from twenty to twenty-five, four more are added. These latter are the four farthest back in a complete set, and are called "wisdom teeth."

The teeth are divided into four kinds, because of their different shapes. Beginning at the middle of either jaw and proceeding backwards, we find the teeth placed in the following order. The first two on either side of the middle have chisel-shaped crowns and are the *incisors.* They are adapted to cutting or biting off the food. The third tooth on either side is the *canine.* It is almost round, very strong, and a firmly set tooth. The next two are the *bicuspids,* and have flat crowns. The next three are much larger than the others, with broad, flat crowns, well suited to grinding the food. They are called the *molars.*

Care of the Teeth.—We are careful to keep our nails clean, because our companions would notice the dirt. But unclean teeth are also open to such inspection, and nothing mars one's appearance more than unsightly, yellow, decayed teeth. A toothbrush and a little silk thread are all the machinery required to keep the teeth clean. Three minutes a day is ample time for this purpose. The preservation of the teeth is not only necessary for one's appearance, but is also vital to the possession of the best health. The care of the teeth is largely a habit; this habit once formed, you would no more think of going to school without brushing your teeth than of going without washing your hands and face or brushing your hair. Teeth that are kept clean cannot decay. Decay always begins upon the surface, and not within the tooth. By cleaning the teeth, the acid secretions that attack their lime salts are removed, as well as the germs of decay.

Much time is wasted by pupils on account of toothache and its companion, earache. One cannot apply himself to study when he has a jumping, thumping toothache. "A stitch in time saves nine." A toothbrush should be used at least twice daily—in the morning, directly after breakfast, and in the evening, before going to bed. Particles of food, if allowed to remain in the mouth, get lodged in the teeth, and decompose. The enamel is attacked, and finally destroyed. After this takes place, but a short time is required for the decay and ulceration of the body of the tooth. The toothbrush used in cleaning the teeth should be soft, and must not be employed so vigorously as to cause the gums to bleed. Lukewarm water should be used; if it contains some salt, so much the better for the teeth. If a good tooth powder cannot be secured, white castile soap will answer very well. We must be especially careful to clean the teeth after eating candy and confections, for sweet substances, when they decompose, form acids. These acids are severe in their attacks on the lime in the teeth. With a soft wood, or a quill toothpick, we can remove the larger food particles that have collected. Metal toothpicks are injurious. With a piece of silk thread, or a small rubber band, we can easily clean between the closest fitting teeth. Cracking nuts with the teeth often breaks the enamel. It may also be cracked by sudden exposure of the teeth to cold, as when drinking ice-water. The saliva deposits on the teeth a yellowish brown substance, called *tartar.* This generally occurs at the line where the surface of the teeth and gums meet. If this deposit is not removed, it may extend toward the root and loosen the tooth. The teeth should be examined twice a year by the dentist, and any cavities promptly filled.

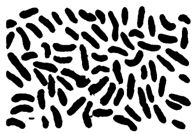
CHAPTER XIV.

DISEASE GERMS.

You are aware of the harm resulting from dust entering the lungs. But still more injurious are the various kinds of live dust that cannot be seen with the naked eye. By live dust we mean little organisms called bacteria. Many of them are the causes of our worst contagious diseases. Some bacteria are beneficial, others are harmful.

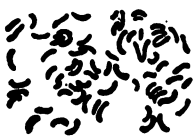
Disease Germs.—Our bodies are good soil for certain germs of disease. Some of these germs will grow in the human body, but not in the body of an animal. Some diseases, such as consumption, are common to both man and animals. The disease germs of consumption live, grow, and flourish as well in the body of a cow as in the body of a man. In fact, many persons take consumption by drinking milk from cows infected with this dreadful disease. We know that the following diseases are caused by germs—consumption, typhoid fever, grippe, diphtheria, cholera, erysipelas, pneumonia, scarlet fever, measles, chicken-pox and small-pox. The little germs, or bacilli, causing different diseases, differ from each other in their appearance. The bacilli that cause typhoid fever do not and cannot cause diphtheria. Though these germs are so small as to be invisible to the naked eye, yet when seen with a powerful microscope they can be readily distinguished from each

other. To the student of the diseases mentioned these minute germs appear as different from each other as grains of wheat and corn do to us. Some of the best known forms are shown on this page.



Diphtheria.

Typhoid Fever.



Asiatic Cholera.

Hog Cholera.

Erysipelas.

Consumption.

Pneumonia.

FIGURE 69.

The Danger.—These germs are about us on every hand. They are in the air, in our food, and in the water we drink. In pioneer days man was afraid of wild animals that might attack him and take his life. Nowadays we know that we may be assailed at any minute by countless millions of invisible creatures, attacking, poisoning, and destroying our bodies, that they may feed themselves. To-day a person is healthy and strong.

To-morrow he may drink a glass of impure water containing germs of typhoid fever. These industrious little bacteria soon derange the entire bodily system, and threaten death. A person having consumption may expectorate on the floor of a car, store, church, or schoolhouse. This sputum contains thousands of disease germs that are capable of causing consumption in any one whose body affords suitable soil for their growth. The sputum dries. This drying does not kill the germs. They become mixed with other dust in the air we breathe, and may find lodgment in our lungs.

Conditions Favoring Disease Germs.—No condition is more favorable to disease germs than impure air. You have seen a gardener's hotbed in which he forces the growth of plants. A schoolroom improperly ventilated is a hotbed of infection and contagion. Impure air affects the nervous system. The wide-awake child becomes listless, drowsy, inattentive, and filled with fatigue poison. Physical growth is stunted because children cannot help but become pale and poorly nourished when they are compelled to breathe foul air. Appetite and digestion fail. Sleep, after a day in a stuffy schoolroom, is disturbed and broken. In this condition children become the ready prey of contagious and infectious disease.

In a poorly ventilated room the poison germs of disease are concentrated. Each cubic foot of air is full of bacteria. In a well-ventilated schoolroom the victims of the contagious diseases are few. The air is not so laden with disease germs, and the child's power to resist disease is greater. If the room is filled with impure air, the reverse is the case, and in such a schoolroom, if one of the pupils takes whooping-cough, diphtheria, or

scarlet fever, many, if not all, of the pupils are liable to contract the same disease.

Filthy surroundings of any kind, as well as uncleanliness of one's person, afford the same favorable conditions for the spread of contagious diseases as does impure air.

How Disease Germs are Transmitted.—Some of the best known contagious diseases of children are spread as follows:

Chicken-Pox—Indefinite; probably by the breath, drinking-cups, and similar means.

Measles—By excretions from the nose; by the breath; by clothing.

Whooping-Cough—By the breath; by expectorations from the throat and lungs.

Scarlet Fever—By contact with cast-off particles of skin from the patient; carried by clothing or by any article containing the poison; germ persistent a long time; can be destroyed only by fire or disinfection.

Grippe—By a germ conveyed by travel, baggage, and in clothing; contagious; latest authorities isolate cases as rigidly as small-pox, because of serious results; in some cases even causes insanity.

Diphtheria—By the breath; by excretions from the throat and nose; germ persistent; similar to scarlet fever germ. Poor drainage, bad sewerage, and a wet cellar under the house are often causes of diphtheria.

Time Required by Various Disease Germs.—Disease germs require a certain time after being received into the body before the symptoms of the disease they cause become manifest. The following table shows the period that elapses in the different

forms of sickness before the disease develops from the germs present.

Disease	Begins usually on the	But may at any time between
Scarlet Fever	4th day	1 and 7 days
Diphtheria	2d day	2 and 5 days
Small-pox	12th day	1 and 16 days
Chicken-pox	14th day	10 and 18 days
Typhoid Fever	21st day	1 and 28 days
Measles	12th day	10 and 15 days
Mumps	19th day	15 and 24 days
Whooping-cough	14th day	7 and 15 days

Typhoid Fever and Water Supply.—The relation between typhoid fever and impurity of the water supply is clearly shown in the accompanying diagram, which presents the comparative death-rate from this disease in the city of Munich, Germany, extending over a period of thirty years. During the period from 1854–1859 the inhabitants of Munich drank water from wells. The city had no system of sewerage, and consequently many of the wells were contaminated by drainage and seepage. The deaths from typhoid fever during this period of neglect were alarming in their number. In 1866 the city authorities became aroused, and began the construction of a system of sewers for part of the city. This resulted in a partial improvement of the water supply, and consequently the deaths were reduced nearly one-half (see second column). This system of sewerage was extended in 1874 to other parts of the city, and the improvement of the water supply resulted in a still further lowering of the death-rate (see third column). In 1881

the city authorities began to condemn and fill up many old wells, extend the sewerage system, and they also gave the people purer water to drink, with the result that in 1884 the deaths from typhoid fever were reduced to 1.4 for every 10,000 inhabitants. That is, in 1854, when the people of Munich drank impure water, the number of deaths from this dread disease was *seventeen times as great* as it was after the city had a good general water supply.

If drinking water is suspected of being impure, all danger can be removed by boiling. Disease germs, such as typhoid bacilli, are killed by boiling, while freezing has little or no effect upon them.

How Bacteria Are Destroyed. — Disease germs are constantly about us, and yet in only comparatively few cases do they gain a hold upon the body and produce sickness. Why are they not more successful in their attacks upon the healthy body?

First—The fluid part of the blood and lymph, called plasma, in a healthy person is of such a chemical nature as to be able to destroy germs of disease.

Second—The white corpuscles of the blood seem to be especially endowed with the capacity of a successful detective. They have the power to seek out the bacteria of disease, which they at once envelop and destroy.

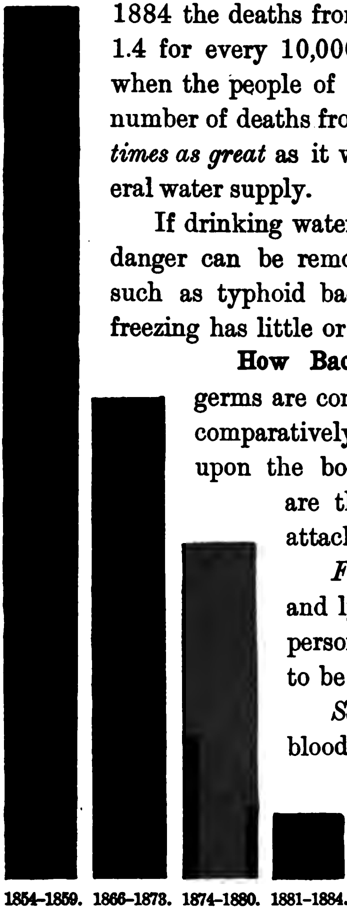


FIGURE 70.

Third—Because people are becoming more observant of sanitary rules. If we keep clean by washing thoroughly every day, properly nourish our bodies, eat digestible foods, take plenty of exercise in the open air, sleep eight or nine hours every night in well-ventilated bedrooms, the microbes of disease will soon go out of business. Bacteria cannot thrive without suitable soil, and the causes that render the body liable to successful attacks upon it are poor nutrition (partial starvation), fatigue, impure air, mental depression, and unwholesome food.

Antitoxin in Diphtheria.—The germs of diphtheria can be raised outside the body in gelatine and beef-broth. The poisons they produce may be injected into the blood of a horse. When this is done, there develops in the plasma of the horse's blood a poison that will kill the germs of diphtheria. This germicide is called *diphtheria antitoxin.* It can be drawn off with the blood of the horse. The blood is allowed to clot, and the clear part (serum) contains the antitoxin. This is preserved in tightly sealed glass tubes, and can be injected into the blood of a person suffering from diphtheria, where it tends to overcome the germs and cure the disease. Diphtheria antitoxin is being successfully used by physicians in battling against this dreadful scourge. The report of the city health officer of Chicago well illustrates the success of antitoxin in the cure of persons ill with diphtheria. In the three years since the use of antitoxin, 1896–1898, inclusive, there was an actual saving of 1,950 lives by means of this diphtheria germ-killer alone. In the 129 cases where antitoxin was used the first or second day of the disease, there was not a single death; while in the 114

cases treated with antitoxin the third day of the disease, there were but three deaths from this disease which is usually so fatal.

Vaccination.—Cows are subject to a disease that is a mild form of small-pox. By vaccination this same disease may be transmitted to a person. If the vaccine "takes," it causes but little trouble, and the person vaccinated is proof against small-pox. The practice of vaccination was introduced by Jenner, who must be regarded a benefactor in providing a means of protecting mankind against the ravages of such a loathsome disease as small-pox.

Disinfectants.—There are substances that really destroy disease germs. Such substances are called disinfectants. These chemicals have the power of purifying the air of a sick-room, and destroying the germs of diphtheria, scarlet fever, and small-pox, that might be lurking in the clothing, bedding and other articles. There are three methods of disinfection. (1) Fire. (2) Dry heat. (3) Chemical poisons. If the bedding, clothing, and rags used in the sick-room in a case of scarlet fever, for example, are of little value, they should be completely destroyed by burning. Furniture, combs, brushes, and the like, should be washed in a 2 per cent solution of carbolic acid. A person caring for and handling the sick person should wash his hands in carbolic acid, 2 per cent solution, or mercuric chloride, one part to 500 parts of water.

To disinfect a sick-room, after the patient has recovered, first wash the walls and floors with soap and water. If the character of the walls will not permit this, they may be rubbed with pieces of fresh bread which will readily gather up the germs.

These should be immediately burned. The room should then be fumigated by burning sulphur. Copperas, chloride of lime, and carbolic acid are the best chemicals to be used in making solutions for disinfecting, while the fumes of burning sulphur will kill any disease germ known. Coffee, sugar, coal, tar, and other substances are often burned in a room to destroy odors. They simply neutralize the offensive odor with one more powerful, but will not destroy disease germs. They are deodorizers, and not disinfectants.

Pure air, pure water, sunlight, and personal cleanliness are nature's disinfectants. Where these are present, disease germs cannot thrive. Let us always take advantage of them that we may win in our battle against the six D's: dust, dirt, darkness, decay, disease, death.

QUESTIONS FOR DISCUSSION.

1. Are there any bacteria that are beneficial?
2. How are some bacteria employed to rid us of certain pests, such as the chinch bug, which destroys fields of grain in many localities?

CHAPTER XV.

SOME DISEASES OF MODERN LIFE.

There are a number of diseases that were practically unknown in ancient times, when people lived more simply. In this day and age, with its rush and pressure, the sharp competition on every hand, the changed conditions of living, the increased liability to fatigue, and the greater tendency to use stimulants and drugs have caused forms of disease to develop that are peculiar to modern life. Not only is there greater liability to the forms of disease resulting from overcrowding in certain districts of our larger cities, but nervous disorders, due to excitement, worry, overwork, the use of narcotic drugs and alcoholic drinks, are on the increase.

Dr. Baer, of the Imperial Board of Health and chief prison physician at Berlin, writes: "In the past wine was used almost wholly by the well-to-do classes, and beer was of such a nature that harm was out of the question. Excessive use of alcohol first began with the art of distillation, and with the obtaining of strong concentrated whisky from corn, potatoes, and the like. With the increased use of whisky a series of diseased conditions has appeared, which are designated by the word 'alcoholism.'

"The climate is an important factor. Drunkenness is more frequent in cold than in warm countries, and is more brutal and injurious in its effects as we go north. Yet this is not

always true, for in tropical regions it is at present spreading fast, and with great injury, especially in newly discovered lands. The accustoming oneself to the use of alcohol causes, sooner or later, a feeling of need for it; alcoholism is not, therefore, an inborn, instinctive need, but an acquired one. Experience teaches that the longer this vice exists in a nation, the greater the vice becomes. Persons who use alcoholic drinks, especially whisky, often become sick and die sooner than the moderate drinkers and non-drinkers. When alcohol is taken habitually it injures the whole constitution; all tissues and organs, and especially the blood, manifest sooner or later a changed condition, with which susceptibility to disease is increased. Alcohol intoxication not only calls out diseases and disturbances that the non-drinker does not have, but it is an old experience that in epidemics of cholera, dysentery and smallpox, drinkers are attacked in larger numbers, and with greater intensity, than non-drinkers. The bad constitution of the blood, the weakness of the changed heart-muscles, the sunken energy of the nervous functions, and the frequent accompanying disease of the brain, cause a bad turn in every disease, and a high death rate."

Says Dr. Legrain, the celebrated French specialist: "Although the effects of alcohol may be only temporary and without serious consequences in a man with a good constitution, who takes it in small quantities on rare occasions, it produces lasting effects in a man of less resistance when taken frequently and in large quantities. Alcohol is not only a poison for the individual. First considered as a poison, then as a remedy, and in the sixteenth century as a universal panacea, which for long

the rich only were able to afford, alcohol has become by degrees an article of general consumption; it has become a poison for the human race from the day when, the demand exceeding the supply, it had to be prepared from all substances capable of fermentation.

"The adulteration of good and pure alcohol for the purpose of making it meet the wants which have grown up everywhere in modern society, has been one of the most powerful factors for the degeneration of our race. Moreover, alcohol has been a more dangerous means of conquest than perhaps the cannon. Introduced to the savage tribes, the fire-water has done more damage than war.

"The progress of commerce and its manifold openings has made alcohol accessible to tribes hitherto untouched by civilization. The consumption of wine, formerly reserved for the rich, has increased everywhere and has become the ordinary drink. The artificial want thus created has caused the manufacture of fermented liquors to increase."

Diseases Due to Alcohol and Narcotics.—The injury that is wrought by alcoholic drinks and narcotics occurs chiefly through the direct effect upon the nervous system. First, there are certain acute diseases caused by the direct injury of alcohol to the nerves and the brain. Second, there are diseases of the other parts of the body because of the influence of alcoholic drinks upon the nerves that govern the nutrition of these organs.

"Alcohol is a terribly frequent cause of nervous diseases. In over-stimulating the brain and spinal cord, it impairs their structure, weakens their functions, and often leads to insanity and crime.

"A small quantity of wine or spirits, taken by one not accustomed to it, congests and excites the brain; the person gets restless and talkative, then dizzy and unable to think clearly. He is soon overcome by sleep, and on awaking feels out of sorts.

"If the dose be increased, the talkativeness is accompanied by indistinct speech, and the dizziness by trembling hands and a staggering walk, both showing loss of control over the voluntary muscles and the will. The sense of touch is dulled; the eyeballs do not move together so as to look exactly at the same point at the same moment, and objects accordingly appear double. (You may imitate this effect by pushing one eyeball gently while looking with both eyes at something.) Then follows profound drunken sleep, which may pass into a condition of deep unconsciousness from which the person cannot be aroused, and in which the breathing is slow and labored because the involuntary nerve-centers which govern the breathing-muscles are affected. Sometimes these centers become at last quite paralyzed and death results, but more often the man sleeps off his drunken fit, to awaken with a state of his nerves to be relieved only by renewed drinking, followed each time by worse results.

"The nerve-centers, however, soon get used to the stimulant; it takes a larger amount each time to make them unsteady, but all the while brain and spinal cord are becoming surely, even if slowly, diseased."—*Professor Martin, of Johns Hopkins University.*

"The first effect that alcohol has on the brain is that of a stimulant, and it probably acts as such in two ways; namely,

by increasing the circulation of the blood through the brain, which is thus roused to greater vigor, and by directly stimulating the nerve cells of the nerve-centers. This stimulating effect is observed chiefly after medium doses, and its result is seen in many individuals by an increase of mental and bodily activity, and of acuteness of perception by the special senses. This beneficial physiological effect is, however, soon replaced by poisonous symptoms if these small doses are repeated, or a large quantity of alcohol is taken at once; for alcohol then becomes a depressant and paralyzer of the central nervous system, and symptoms of intoxication appear. This depressing effect is, as Brunton points out, a form of paralysis. The higher centers of the brain are first affected, and then the lower. The perceptive centers are paralyzed so that correct judgment is no longer possible, while the emotions are uncontrolled and thrown out of working gear, fits of boisterous hilarity and emotional depression being common symptoms. Speech becomes disordered, and symptoms of loss of control of the muscles, due probably to an effect on the cerebellum, appear. The breathing center in the medulla then becomes affected, and at this stage there is deep unconsciousness with hoarse breathing or snoring, while the action of the heart still continues, even after respiration has stopped. There is no question that alcohol taken in such quantities, sufficient to act upon the higher centers of the brain, does an infinite amount of harm."—*Dr. Murphy.*

That there are many cases of nervous disease directly due to the excessive use of alcoholic stimulants, narcotics, and drugs, is plainly shown by a glance at the records on file in connection with the case histories at our various insane hos-

pitals and sanitariums. There is scarcely any form of insanity that cannot be occasioned by the alcoholic habit. Of course there are many patients in our insane hospitals who have never used alcohol, but there is not a single form of insanity known to the brain specialists of to-day that cannot be produced by alcoholism.

In one person alcoholic excess will produce a state of continued excitability (*mania*). In another there will be continued depression and sadness, with tendency to suicide (*melancholia*). Then in still others we have a shrinkage of the brain cells—a brain hardening—resulting in *general paralysis*. In addition to these, in my experience while engaged in examining patients on their admission to one of the largest insane hospitals in the world, I have found many cases of emotional insanity, of mania to commit murder, of a general and progressive mental weakness, of delusions of persecution, of an uncontrollable desire to set fire to buildings and destroy property, of changed and disordered senses, of depraved tastes with love for filth and a mania to live like an animal, of fixed ideas that the food was poisoned, with refusal to eat, requiring forced feeding, of extraordinary ideas of grandeur and wealth—all of these forms of mental disease and many others, arising from alcoholic excesses.

Dipsomania is the name given to a form of mental and nervous disease in which there is such strong craving for drink that the person is not responsible for his acts committed to secure alcohol. It becomes a mad thirst. He is insane. In one case with which I am familiar a man cut off his hand with an ax and called for rum in which to immerse the bleeding

stump of his arm. When the rum was brought he drank it, unmindful of his suffering. This man maimed himself for life to satisfy for a brief moment his mad thirst for drink. He was adjudged insane and sent to the state hospital. His disease was dipsomania.

Delirium Tremens is a form of temporary mental disease, due alone to alcoholic excess in persons whose nervous systems have been poisoned and shattered by the prolonged use of large quantities of alcoholic spirits. At the height of the attack the person is a raving maniac. In his racked mental condition he has illusions of sight, and sees foul and terrible creeping things crawling about his room and over his body.

NARCOTICS.

Some drugs have the power of making the cells of the brain unable to work for a time. They stupefy the brain, deaden the senses, and produce what seems to be sound sleep. Any substance that thus deadens the senses and tends to produce unconsciousness is a *narcotic*. Morphine, opium, chloral, cocaine, laudanum, chloroform, ether, and the bromides of sodium and potassium are narcotics. Tobacco has the effect of a narcotic on most people. At certain periods of a disease, as in the delirium of a fever, when sleep must be secured, or in a surgical operation when the unconscious stupor of the patient is necessary to success, the narcotic drugs are a great boon. They have their priceless value as medicine, but like other medicines, should be given at the proper time and in proper doses prescribed by the physician in charge. Taken habitually, the

narcotics cause diseased conditions to arise, shatter the nervous system, and weaken the mind.

We must, however, distinguish between the two classes of poisons that mar the health and occasion many of the diseases of modern life. There are certain poisons imposed upon a man because of the occupation he pursues. Workers in lead, mercury and sulphur of carbon are quite apt to become diseased by the slow poison of these substances. The antimony poisoning of the type-setter is a disease known only to the present generation, and is due to the continual handling of type containing this metal.

But the poisons that cause by far the greatest havoc are those sought voluntarily by a man on account of the pleasures they give, such as morphine, cocaine, opium, and hashish. The abuse of morphine has greatly increased the last few years. The morphine habit is most vicious. It impairs the mental traits, deadens the senses, weakens the will, destroys the memory, and blunts all moral sense. No opium fiend or victim of the morphine habit can ever be believed. He seems unable to tell the truth.

Opium is a gummy substance gained from the poppy. It is used in various forms. (1) Gum opium, which is rolled up in pills and smoked; (2) laudanum, a solution of alcohol and opium; (3) sulphate of morphia, or morphine, and solutions containing it; (4) paregoric, soothing syrup and various patent medicines containing opium as an important ingredient. There are people who become addicted to the patent medicine habit much as the drunkard becomes enslaved to the alcoholic habit. The stupor caused by these patent medicines is as bad in every

way as the ill effects of opium smoking or alcoholic excess. Patent medicine drunkenness is just as bad as any other form of drunkenness. The continued use of opium deranges all the digestive processes, diseases the brain and nervous system and degrades the character.

Self-Control and the Appetites.—One of the most serious effects of continued indulgence of the appetites is the weakening of the will. No one should eat food that is harmful simply because it tastes well. There are foods that please the palate but which, if eaten, would ruin the digestion. We should always deny ourselves unwholesome foods or drinks, however much we may "like" them. By doing this we insure ourselves not only the possession of healthy bodies, but we exercise control over the appetites and thus greatly strengthen the will. Every act of self-control strengthens the will. Success in life is assured to the person who has developed a strong, sturdy, determined will. He will leave no duty undone; all his obligations will be squarely met; promises will always be kept, and no pledge unfulfilled.

WILL.

There is no chance, no destiny, no fate,
Can circumvent, or hinder, or control
The firm resolve of a determined soul.
Gifts count for nothing: Will alone is great,
All things give way before it soon or late.
What obstacle can stay the mighty force
Of the sea-seeking river in its course,
Or cause the ascending orb of day to wait?

Each well-born soul must win what it deserves.
Let the fool prate of luck—the fortunate is he
Whose earnest purpose never swerves,
Whose slightest action or inaction serves
The one great aim. Why, even Death stands still
And waits an hour sometimes for such a will!

SUMMARY OF THE EFFECTS OF THE CONTINUED USE OF ALCOHOLIC DRINKS UPON VARIOUS BODILY ORGANS.

The *stomach* becomes inflamed. It fails to properly secrete the gastric juice. Indigestion results.

The *liver* hardens and shrinks. This unfits it to perform its important duties. When the liver is "out of order" the general health is sure to be impaired.

The *skin* has an increased amount of blood sent to it. The glands are hindered in their activity so necessary to the preservation of health. More work is thus thrown upon the kidneys.

The *kidneys* are stimulated to work beyond their power in removing waste products. This overwork may cause diseased conditions to arise (Bright's disease).

The *muscles* lose strength, partly because of increased fat; their power of endurance is also lessened.

The *blood* becomes of poorer quality. Its corpuscles cannot carry so much oxygen to the tissues of the body. The temperature of the body is not normal.

The *heart* is overstimulated, and is deprived of the rest it needs in order to maintain healthy regular activity. The walls of the arteries are weakened by means of fatty deposits.

In the *lungs* the walls of the air-cells may become thickened and lose their elasticity. The size of the air-sacs is gradually reduced, thus decreasing the breathing capacity of the lungs.

The *nerves* and the *brain* are probably the most seriously affected of all the organs. Senses are blunted, there is over-stimulation of the cells in brain and spinal cord. Delirium tremens, dipsomania, and other nervous and mental diseases may ensue.

Alcohol affects the *eyes* in lessening the quickness and acuteness of vision. Scougal and other authorities affirm that the quickness of *hearing* is impaired by the use of alcoholic drinks.

No one drunkard ever suffered from all of these diseases, and many of them may occur in persons who never use alcohol, but some one or more of them is quite certain to develop in the body of the habitual drinker. Every one of these diseased conditions are more often due to alcohol than to any other single cause.

CHAPTER XVI.

PHYSICAL EXERCISE.

The study of the human body, whether such study is brief or extended, soon convinces one that neglect is one of the greatest foes to health. One form of neglect that frequently causes serious and widespread injury is the failure to take exercise. To be healthy we must exercise regularly and judiciously. By exercising judiciously, we mean that the right amount and proper form of exercise must be taken. Want of strength, incomplete growth, lack of development, loss of symmetry—all these may result from disregarding our duty to take daily exercise of the right kind.

Exercise Necessary to Health.—We have learned that constant use of a muscle makes it larger, harder, and stronger. But exercise should be for the entire body, and not for a single group of muscles. We cannot afford to develop one particular part of the body and neglect some other portion. Perfect lungs and a healthy heart are of much greater value to a person than a few extra bunches of muscles. Judicious exercise promotes health because it accomplishes, among other results, the following:

1. It stimulates growth.
2. It makes growth symmetrical.

3. It develops skill, quickness, accuracy, strength, and endurance.
4. It incites the organs to do their best work.
5. It develops poise of body.
6. It acts as an incentive to the best mental work.

Exercise According to Development. — The five-year-old child should not attempt the same forms of exercise as the boy or girl of twelve, any more than he would try to wear the same clothes. Such forms of exercise are not adapted to his stage of development. The same exercises that are beneficial at certain periods of growth prove of no value at others, while at some stages of development they are positively harmful. There are four periods of development of which we will speak with a view of presenting the forms of exercise best suited to each period.

First Period—From Six to Nine Years of Age.—Exercise during this period should be such as will incite growth by animating the organic activities, such as breathing and the circulation of the blood. The forms of exercise must also be of a kind that will cause the formation of more blood. This is checked by the compulsory sitting posture of the schoolroom. The exercises of this period, to do the most good, should be in the open air, and should be recreative games and plays, because these animate the nerves and increase joy. Cheer, you remember, is necessary to the best growth. That exercise will, as a rule, do the most good which we most enjoy.

The best exercises during this period are the easy games of motion, such as "Ring Around a Rosy," "London Bridge is Falling Down," "King, King Calico," and some of the simpler games of "Tag."

The exercises that should be forbidden during this period are any and all of those that tend to strain even a small number of muscles, for they are likely to consume matter needed for growth and development. Rope jumping is generally injurious during this period, because of the condition of the heart, especially between the ages of eight and nine years. Later it is a good exercise if indulged in moderation.

Second Period—From Nine to Fourteen.—The exercises during this period of rapid growth must continue to assist in the formation of blood, as during the first period. In addition we must have exercises that tend to create an easy carriage of the body and a graceful walk. Either dancing the easier waltz steps, marching, or military drill, will accomplish much in this direction at this important stage of development. Exercises during the latter part of this period should also develop skill. The forms of exercise especially suited to this period are tactics and calisthenics in the gymnasium, and in the open air the more lively games calling for more vigor than those suggested for the first period. Good games for this period are "Race-Tag" and "Prisoner's Base," which are played as follows:

Race-Tag.—The leader of the game stands on an elevation of the playground, or in front and in sight of the players who have formed parties at a distance of from two to six paces from one another. The leader swings a disc, painted white on the one side and black on the other. The parties have chosen their colors. The disc is suddenly held in such a way that either side, white or black, becomes visible, when the team, whose color is seen, must run, the other team giving chase and trying to secure as many prisoners as possible by holding or tagging

them, before they can reach the boundaries of the playground. Prisoners are barred from further participation, and form in the rear of the disc-holder. The game can also be played in such a manner that the side whose color is shown shall quickly drop prone on the ground, those who are tagged before dropping, or the last to drop to the ground, being barred out. In this last form the players may intermingle.

Prisoner's Base.—The players are divided into two equal parties, each having a goal and a prison, a square base at the right end of the goal and immediately in front of it. The goals may be from 30 to 75 feet apart, and from 20 to 30 feet wide. One of the party now steps forward and challenges the opposing party to catch him if it can. If he should be caught or tapped by any one of the opposing party before he can reach his own goal again, he is made prisoner and brought to the base or prison of the enemy, where he remains until rescued by some one of his own party. This can be done by a swift and courageous runner only, who must tap the prisoner or join hands with him before he can be caught, when he may proceed to his own goal again unmolested. Both parties continue these sallies until the party which is successful in capturing the most of the opposing party, so that it is forced to surrender, wins the game. After each sally, or challenge, the player must return to his base, before attempting another sally.

Simple ball games, such as "One Old Cat," should be played when the boy is from nine to eleven years old, but when he becomes twelve he should begin to play such games as shinny, polo, hockey, and the more intricate game of baseball, which will develop his skill, courage and judgment. There

should be exercise in the gymnasium during the latter part of this period to cultivate skill on apparatus.

Exercises, especially during this period, should never be continued to exhaustion, but should stop when fatigue begins to manifest itself.

Third Period—From Fourteen to Twenty.—This is essentially the period of greatest development, and is therefore the one in which the greatest care must be used in selecting judicious exercises. These must be, first of all, those exercises that incite the heart and lungs to strong activity. These organs practically complete their development during this period. The girl or boy who has weak lungs at the age of eighteen or twenty, will probably be similarly affected through life. The games must be such as to develop skill, daring, and courage. There should be baseball games, and any other games that develop alertness. It is during this period that we should develop the "hair-trigger," race-horse kind of muscle, rather than draft-horse muscle. Quality rather than quantity is desired. Quickness rather than bulk should be the object. Short races, running, jumping, swimming, and rowing are excellent at this age. There should, however, be no heavy exercises of endurance at this period. One great mistake made by boys at this age at their school "athletic meets," is to imitate the colleges in the events contested. No one should attempt to run a mile before he is twenty, nor should he take part in tug-of-war contests. Such events call for too great endurance for this age. The football games of high-school boys should embrace two halves of not more than twenty minutes each—fifteen would be even better.

Fourth Period—From Twenty to Thirty. — It is during this period that the individual is capable of his highest achievements in skill and quickness. Easy calisthenics are of no practical benefit during this period. There should be exercise calling for endurance and general exercise of strength. Quickness and skill in the use of one's muscles can rarely if ever be developed after the age of thirty. The same is true with respect to gracefulness of bodily movement.

Gymnastics and Games Compared.—Gymnastics are an excellent innovation in our modern schools. They correct posture, they are a change from mental work, but often there is such a sameness about such exercises that one does not obtain the same enjoyment as from play. Gymnastics, like work, soon become monotonous. The boy on the farm gets plenty of exercise out of doors. He gets up early, does the chores, and walks a long way to school. He is laying the foundation of a healthy body in after life. But his exercise comes in the form of work, and "all work and no play makes Jack a dull boy." Games accomplish something for the growing boy and girl that work alone cannot supply. Games train the mind as well as the body. They develop judgment, quickness, determination, in an easy manner, and without any special effort in this direction, because of the enjoyment experienced. In baseball the boy develops judgment, skill, daring, and courage. One cannot learn to distinguish between balls and strikes without exercising judgment. He must use skill in batting. It takes daring to try to steal a base when pitcher and catcher are alert, and courage is certainly needed when one is called upon to "slide for the home plate." Learning to swim or skate requires de-

termination and self-reliance. And so there are a number of manly qualities that are furthered and fostered by health-giving sports. Gymnastics, under the direction of a teacher, are excellent for the purpose of correcting special defects of posture in sitting, standing, and walking. But no system of gymnastics can take the place of rollicking, romping play out of doors. The best gymnastics are those which approach play as nearly as possible.

Lack of exercise during school work is much more common than excessive exercise, especially in girls. The general health of girls often becomes impaired, digestion is enfeebled, the circulation is not good, and nervousness is manifest. Tendency to lung diseases, such as consumption, is greatly increased. The effect on bodily figure shows itself in flabby muscles, drooping shoulders, flat chest, stooping walk, and curvature of the spine. Girls should play and romp with the same freedom that boys do. Health is as necessary to a girl as it is to a boy. But perfect health is impossible without good and sufficient exercise.

Walking is one of the most natural methods of exercise. It is convenient and pleasurable, but should be taken with a zest, and not from a sense of compulsion. It is suitable to all persons and all ages. If properly taken, it is a mode of activity that calls into action all the muscles except those of the arms. It deepens breathing, assists digestion, and improves circulation. Walk erect with the shoulders thrown back, chin out, and look the world in the face.

Running and *jumping* are modifications of walking and are likewise beneficial to those for whom they are not too violent.

A brisk walk, however, is better than a slow walk. If a man could move his legs proportionately as fast as an ant, he would travel at the rate of about 800 miles an hour. *Bicycling* is a popular form of exercise. Its advantage is that it is in the open air and exhilarating. It is adapted to all persons and all ages. There is, however, grave danger of over-taxing the heart if one yields to the temptation of long runs or excessive bursts of speed. As in any other, this exercise should not be continued to the point of fatigue. The handle-bars should be high enough to allow a fairly upright position. A poor saddle will do great injury. *Tennis* is a fine game, suitable for girls as well as boys. It will develop every muscle of the body. It is not a violent exercise, does not make the muscles sore, and there is no danger of injury. It develops quickness, skill, keenness, and judgment. *Football* is a game of brains as well as brawn. It develops will, courage, obedience to orders, and has good disciplinary effect. It tends to make active, fearless, cool-headed men. The objections to this game arise because of the injuries that occasionally result. These are comparatively few, and would be slight if the rules of the game were enforced. No vigorous exercise exists in which there is absolutely no risk. There is no more danger in the game of football for a well-developed boy than there is in climbing trees by his younger brother, and surely no boy should be permitted to grow up without climbing trees. The Duke of Wellington said the battle of Waterloo was won on the football field at Rugby. One cannot play football without the consciousness that he has a place to fill, and that he must fill it. The team work, or concerted action, in football is one of the reasons of its great value.

General Suggestions.—Exercise should be taken regularly. Violent exercise should not be indulged in within a half-hour before eating nor within two hours after a hearty meal. In preparing for athletic contests, the increase in exercise should come gradually, so that the heart and lungs will not suffer from over-exertion. Clothing worn while exercising should be comparatively light in weight and should be loose-fitting so as to admit of the freest possible activity of the muscles. Great care should be taken to avoid taking cold. When warm from exercise there is a temptation to sit on the ground or in a cool place. A cold may be thus contracted which may lead to fatal lung disease.

QUOTATIONS.

"We have not to train a soul alone, nor only a body, but a man; and we cannot divide him."—*Montaigne.*

"A sound mind in a sound body is a short but full description of a happy state in this world; he that has these two has but little more to wish for, and he that lacks either of them will be but little better for anything else he may possess."—*John Locke.*

"The truth is that happiness is the most powerful of tonics. By accelerating the circulation of the blood, it facilitates the performance of every function, and so tends alike to increase health when it exists, and to restore it when it has been lost. The extreme interest felt by children in their games, and the riotous glee with which they carry on their rougher frolics, are of as much importance as the accompanying exertion."—*Herbert Spencer.*

CHAPTER XVII.

FIRST AID TO THE INJURED.

Very often a little knowledge of what is best to be done in case of accident may save life. Accidents will happen in the best regulated schools, and it is important for us all to know what is the wisest course to pursue until the doctor comes. The following accidents are most common:

Fainting.—When this occurs it is usually because the room is overheated or poorly ventilated. Place the patient on his back with his head low, no pillows of any kind being used. Loosen all the clothing about the neck. Place the patient in a current of air, or quickly carry him outside if possible. Keep the crowd back by all means. Sprinkle a little cold water on the face. Never pour anything down the throat of an unconscious patient, for it may cause him to choke to death.

Suffocation.—Sometimes a peachstone, tin whistle, marble, or similar object, is thoughtlessly held in the mouth. It may then slip back into the larynx, obstructing breathing. Call a doctor immediately, for such an accident is always serious. In the mean time try to reach the foreign object by placing your finger in the back of the patient's throat. Even if the object cannot be reached, vomiting is thus caused, and this may dislodge it.

Bleeding from the Nose.—This is quite a common occurrence among children, and, as a rule, is not alarming. Place the patient erect in a chair, or have him stand, and induce him to stretch both arms high above the head. Press the tip of the nose between the finger and thumb, or press the upper lip. Put a piece of ice or a cold cloth at the back of the neck. This cold shock will cause the blood vessels to shrink. Loosen the collar so as to allow free circulation. Also apply cold water to the nose and forehead. If these measures do not stop the hemorrhage, inject cold water containing a little salt or soda into the nose. During an attack, do not blow the nose, as this will start further bleeding.

FIGURE 71.—Bandage in Arterial Bleeding. Dotted lines show course of the arteries.

Bleeding from an Artery.—If the blood comes in jets or spurts, it is an artery that is bleeding. This may prove serious. Fortunately, at most parts of the body the arteries are deeply buried in the flesh. A severed artery calls for prompt action. Put firm pressure upon the bleeding part between the wound and the heart. The pressure is best applied, in case the wound is in the arm or leg, by taking a folded handkerchief, tying a knot in its center, and placing this knot over the artery. Tie it loosely around the limb, but with a good knot. Place a stick

under the bandage and twist it round and round until tight enough to stop the hemorrhage. (Fig. 71.)

Bleeding from the Veins.—The patient should lie quiet. Raise the bleeding member, and wash the wound with cold or hot, but *clean*, water. Dirty water may introduce bacteria into the wound. Then tie a pad of soft clean linen so as to press firmly upon the injury.

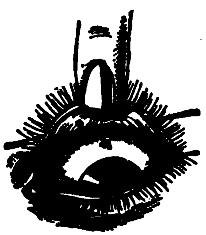


FIGURE 72.—Removing a Foreign Particle from the Eye.

Foreign Bodies in the Ear or Nostril.—A thoughtless child will sometimes push an object into the nostril or ear until it is beyond reach. If it is a pea, bean, or grain of corn, the heat and moisture will cause it to swell. It is best to go to the physician at once and have the object removed. If the obstruction is in one of the nostrils, hold the other nostril shut and blow in the patient's mouth. The air will force out the object.

Foreign Bodies in the Eye.—Cinders and dust particles get into the eye in spite of its excellent protection. This causes severe pain. Rubbing the eye will make matters worse. Open the eye, and perhaps tears will wash out the offending particle. A drop of sweet oil or a grain of flaxseed put into the eye will afford relief. Or draw the upper lid down over the under one; the lashes of the under lid may remove the cause of irritation. A still better method is to place a match or wooden toothpick on top of the eyelid, then catch hold of the lashes and turn the lid back. (Fig. 72.) The particle will in all probability be seen clinging to the under surface of the lid and can be easily removed with the corner of a handkerchief.

Burns.—The best application for a burn is a solution of common cooking soda, using about a tablespoonful of soda to a glass of water. Afterwards apply vaseline. A mixture of equal parts of linseed oil and lime water is excellent for dressing burns. Apply loosely with cotton.

Bee Stings.—The stings of bees, wasps, hornets, and yellow-jackets are relieved by first bathing in hot water and squeezing out the poison. Then apply the solution of soda mentioned in the preceding paragraph. This same treatment will also relieve in the case of nettle stings. Ammonia is also excellent in these injuries, and in mosquito bites. Boys also know that binding mud over a sting gives relief. Be careful to always extract the "stinger" before treatment is applied.

Burning Clothing.—Quick work is necessary when a person's clothes catch fire, for in a very few minutes he will be enveloped in flames and so severely burnt that recovery will be impossible. Place such a person flat on the ground immediately; smother the flames with a coat, shawl, blanket, piece of carpet, or anything at hand. If on fire yourself, do not run for help, but lie down flat, and roll over and over on the ground or floor to smother out the flames.

Sunstroke.—When overcome by the heat, or suffering from a sunstroke, lie down in a cool, shady place. The face and hands should be sponged with cold water. As soon as possible the patient should be removed to a cool room, and placed on a couch with his head elevated. Apply cold cloths, or better still, the ice-bag, to the head, back of the neck, and spine, and warmth to the legs and feet. A drink of hot coffee or tea, or beef extract, will stimulate the weakened heart.

Broken Bones.—There is no urgent need for treating a broken limb before the surgeon arrives. If it is necessary to move the patient, he should be carried on a board, door, or an equally solid improvised stretcher, rather than loosely in the arms, so as to prevent the broken limb from being moved before the doctor comes.

Frost Bite.—Immediately rub the frozen parts with snow, or apply very cold water. When they begin to sting and burn, cease the rubbing. Ordinary coal oil is also an excellent application for frost bite. Treatment should always take place in a cold room before the frozen parts have become warm. The patient should then become warm gradually.

Learn to Swim.—Every child should be taught to swim and to float. Besides being an excellent exercise in and of itself, swimming is an accomplishment that may be of service in saving the lives of others. A cool-headed, expert swimmer may save a boat-load of people.

Treatment of the Drowned.—[As given in Bulletin 14, Michigan Board of Health.] Three things to be done: Restore breathing; restore animal heat; restore the circulation of the blood.

RULE 1.—*Remove all obstructions to breathing.* INSTANTLY loosen or cut apart all neck or waist bands; turn the patient on his face, with the head down hill; stand astride the hips with your face towards his head, and locking your fingers together under his body, raise it as high as you can without lifting the forehead off the ground (Fig. 73), and give the body a quick jerk to remove mucus from the throat and water from the windpipe; hold the body suspended long enough to slowly

count ONE, TWO, THREE, FOUR, FIVE, repeating the jerk more gently two or three times. Then act by Rule 2.

RULE 2.—Keep the patient face downward, and maintaining all the while your position astride the body, grasp the points of the shoulders by the clothing, or, if the body is naked, thrust your fingers into the armpits, clasping your thumbs over

FIGURE 73.—Resuscitation from Drowning. (Position 1.)

the points of the shoulders, and *raise the chest as high as you can* (Fig. 74) without lifting the head quite off the ground, and hold it long enough to *slowly* count ONE, TWO, THREE. Replace him on the ground, with his forehead on his flexed arm, the neck straightened out, and the mouth and nose free. Place your elbows against your knees, and your hands upon the sides of his chest (Fig. 75) *over the lower ribs, and press downward and inward with increasing force* long enough to slowly count ONE, TWO. Suddenly let go, grasp the shoulders as before, and raise the chest (Fig. 74); then press upon the ribs (Fig. 75).

These alternate movements should be repeated ten to fifteen times a minute for an hour at least, unless breathing is restored sooner. Use the same regularity as in natural breathing.

DO NOT GIVE UP TOO SOON.—You are working for life. Any

FIGURE 74.—Resuscitation from Drowning. (Position 2.)

time within two hours you may be on the very threshold of success without there being any sign of it.

RULE 3.—After breathing has commenced, RESTORE THE ANIMAL HEAT. Wrap him in warm blankets, apply bottles of hot water, hot bricks, or anything to restore heat. *Warm the head nearly as fast as the body, lest convulsions come on.* Rubbing the body with warm cloths or the hand, and slapping the fleshy parts may assist to restore warmth, the circulation of the blood, and the breathing also. The rubbing of the limbs should always be from the extremities toward the body. If the patient

can SURELY swallow, give hot coffee, tea, or milk. Place the patient in a warm bed, and give him plenty of fresh air; keep him quiet.

Beware!—Avoid Delay.—A MOMENT may turn the scale for life and death. Dry ground, shelter, warmth, or stimulants, at this moment are nothing—ARTIFICIAL BREATHING IS EVERYTHING—is the ONE REMEDY—all others are secondary.

FIGURE 75.—Resuscitation from Drowning. (Position 3.)

Do not stop to remove wet clothing. Precious time is wasted and the patient may be fatally chilled by exposure of the naked body, even in summer. Give all your attention and effort to restore breathing by forcing air into and out of the lungs. If the breathing has just ceased, a smart slap on the face, or a vigorous twist of the hair will sometimes start it again, and may be tried incidentally, as may also pressing the finger upon the root of the tongue.

Before natural breathing is fully restored, do [illegible] let the patient lie on his back unless some person hold[illegible] tongue forward. The tongue by falling back may close [illegible] windpipe, and cause fatal choking.

If several persons are present, one may hold the head steady, keeping the neck nearly straight; others may remove wet clothing, substituting at once clothing which is dry and warm; they may also chafe the limbs, rubbing toward the body, and thus promote the circulation.

Prevent persons from crowding around the patient and excluding fresh air; also from trying to give stimulants before the patient can swallow. The first causes suffocation; the second, fatal choking.

Poisons.—A few of the common drugs kept about the house are more or less poisonous. The proper antidote for each poison kept in the house should be known. It is a good rule to procure, at the time any poison is purchased, the best antidote for that poison. When a person has taken poison, three things are to be accomplished; (1) to get rid of the poison; (2) to neutralize what remains in the system; (3) to remedy the effect already produced.

Whenever it is suspected that a poison has been swallowed, an emetic should be given. The most common emetic is mustard; mix a tablespoonful with a cup of warm water; give half of this mixture, and in a few moments give the remainder. Compel the patient to drink large quantities of warm water. Provoke vomiting by putting the finger or a teaspoon at the back of the throat. If mustard is not at hand, use a strong solution of common salt or alum. After the vomiting it is well to give a glass of milk, in which are the well-beaten whites of two eggs. It must be remembered that these suggestions are given as directions until the doctor arrives. A physician should always be summoned because of the necessary after-treatment.

CHAPTER XVIII.

SELECTED READINGS FOR REVIEW STUDY.

The study of literature in the school grades is a distinctive feature marking the advance and improvement of the last ten years. One result of this reading and study of good literature is that every school child knows Oliver Wendell Holmes as a famous American poet, essayist, and novelist. But because of his literary glory his achievements in physiology and medicine are quite generally forgotten. For thirty-five years he was actively engaged as a teacher of anatomy and physiology in the Medical School of Harvard University. The following selections were made for you to read and study, not merely for their literary excellence, but more particularly for the aid they will give you in reviewing the general subjects of physiology and hygiene. You should carefully read each of these selections as a whole, and then study each paragraph with special reference to its teachings of anatomy, physiology and hygiene. The stanzas at the close are taken from his poem "The Living Temple," sometimes referred to by the author as "The Anatomist's Hymn."

The body may be studied as the geographer studies the earth, or as the geologist studies it. A surgeon who is to operate upon any part must make a very careful study of its *geography*. A very slight deviation of his knife may be the death of his patient.

But the *geology* of the body, the list of *anatomical elements* into which the microscope easily resolves it, is quite another matter.

A slight prick of the finger with a cambric needle supplies a point, not a drop, of blood, which we spread on a slip of glass,

cover with another much thinner piece of glass, and look at in the microscope. You see a vast number of flattened disks rolling around in a clear fluid, or piled in columns like rouleaux of coin. Each of these is about one-fiftieth of the diameter of the dot over this *i*, or the period at the end of this sentence, as it will be seen in fine print. You have many millions of them circulating in your body,—I am almost afraid to say how many by calculation. Here and there is a pearly looking globule, a little larger than one of the disks. These are the red and the white blood corpuscles, which are carried along by the pale fluid to which the red ones give its color, as the grains of sand are whirled along with a rapid torrent. The blood, then, you see, is not like red ink, but more like water with red and white currants, one of the latter to some hundreds of the former, floating in it, not dissolved in it.

The solids of the body are made up chiefly of *cells* or particles originally rounded, often more or less altered in form, or of *fibers*. Here is a minute scrap of fat, half as large as the head of a pin, perhaps. You see in the microscope that it consists of a group of little vescicles, or cells, looking like miniature soap-bubbles. That part of the brain with which we think is made up of cells of a different aspect. They are granular instead of being clear like the fat cells. Each of them has a little spot upon it called the nucleus, and that has a smaller spot called the nucleolus.

Now let us examine some fibers. These fine, wavy threads are the material employed by nature for a larger variety of purposes than any other anatomical element. They look like silk floss as you see them here. But they take many aspects.

Made into bands and cords they tie the joints as ligaments, and form the attachments of muscles as tendons. Woven into dense membranes they wrap the limbs in firm envelopes, sheathing each separate muscle, and binding the whole muscles of a part in a common covering. Shaped into stout bags they furnish protections for the brain, the heart, the eye, and other organs. In looser masses they form the packing of all the delicate machinery of life, separating the parts from each other, and yet uniting them as a whole, much as the cement at once separates and unites the stones or bricks of a wall, or more nearly as the cotton-wool packs the fragile articles it is used to protect.

The muscles are the servants of the brain. To each bundle of them runs a nervous telegraphic cord, which compels it to every act good or bad which it does, to every word right or wrong which it utters. Your muscles will murder as readily as they will embrace a fellow-creature. They will curse as willingly as they will bless, if your brain telegraphs them to do it. Your red flesh has no more conscience or compassion than a tiger's or a hyena's.

We look at a bit of nerve in the microscope. It seems at first as if it were simply fibrous, but examining it we see that each fiber is a *tube*, with thick walls and a kind of pith in its center—looking something like a thermometer-tube with transparent contents. Through these canals flows in the knowledge of all that is outside ourselves, nay, of our own bodies, to our consciousness, which has its seat in those granular spotted cells of the brain before mentioned. Through these stream forth also from the brain-cells the mandates of the will.

The bones are more than half mineral substance, lime being their basis. Our earthly house of this tabernacle is built upon a rock. The teeth are still more largely mineral in their composition, yet both bones and teeth are penetrated by canals which carry nourishment through their substance.

We cannot use our bodies in any manner without wearing away some portions of them, or so far deteriorating those portions that they become unfit for their duties. These must therefore be got rid of and their place supplied with fresh materials. It is obvious, then, that we change our bodies as we change our clothes. A strong man leading an active life takes between two and three pounds of dry food daily, and five or six of liquids. He receives into his lungs between four and five thousand gallons of air every twenty-four hours, of which he absorbs between two and three pounds. In a year, therefore, such a man takes into his system about three thousand pounds of foreign material, or twenty times his own weight. That is, if he weighs one hundred and fifty pounds, he has been made over twenty times in the course of a year, or as often as once every two or three weeks.

We are perishing and being born again at every instant. "I die daily" is true of all that live. If we cease to die, particle by particle, and to be born anew in the same proportion, the whole movement of life comes to an end; and swift, universal, irreparable decay resolves our frames into the parent elements.

The products of the internal fire which consumes us over and over again every year pass off mainly in smoke and steam from the lungs and the skin. The smoke is invisible only because the combustion is so perfect. The steam is plain enough in our

breaths on a frosty morning; and an over-driven horse will show us on a larger scale the cloud that is always arising from our own bodies.

A plant must find in the soil any elements it requires, and which the air does not furnish. We feed our cereals with phosphate of lime, for instance, and we know that unless we keep replenishing the soil it is soon exhausted of this and other important constituents. So if a hen does not get lime enough in her food, she lays soft or thin shelled eggs. And just as certainly as a man does not get lime enough in his food his bones will be liable to soften and bend under him.

These little striped fibers, which do the bidding of your will, must be exercised or they will undergo a gradual change, diminishing in size or in number, or perhaps being converted into fat, and thus substituting a burden for a force.

CONDITIONS OF HEALTH.

Methods of Heating.—Open fire-places, wood or soft coal, aided, if need be, by moderate furnace heat in the coldest weather, are the first requisites for health, comfort, and cheerfulness. Even heating by steam or hot water is no substitute for the blaze of the open fire-place and the brisk circulation of air kept up by the breathing passage of a room—its chimney.

Sunlight.—Warmth, however, and an atmosphere containing a due amount of moisture, are not enough to secure health without insuring the daily presence of a sufficient amount of light. The dark side of a street is far more subject to disease than the light side. Sir James Wylie found three times as

many cases of disease on the shaded side of the barracks at St. Petersburg as on the other side.

Ventilation.—The air we breathe is the next point to be touched upon. If we inspire and expire forty hogsheads of air a day, rob it of some pounds of oxygen, and load it with other pounds of carbonic acid gas, we must need a very large supply for our daily use. The ventilation of buildings, public and private, is accomplished easily and safely enough if people will take the pains and spend the money. Yet it is sadly neglected by those who spare no trouble and expense for luxuries much less important.

Air and Water are, of course, the principal substances on which we feed. From these we get our supplies of oxygen and hydrogen. Why not of nitrogen, as four-fifths of the air consist of that gas? Thirty hogsheads of nitrogen pass in and out of our lungs daily, and yet it can hardly be shown that we take toll of it to the amount of a cubic inch. We are all our lives soaking in a great ærial ocean made up chiefly of nitrogen, and we shall die of nitrogen famine if we do not have a portion of it supplied to us in our solid or our liquid food.

"Water, water everywhere,
And not a drop to drink."

Nitrogen from Foods.—We get our nitrogen from the cereals that furnish our bread, from peas and beans, from milk, cheese, and from animal food, except its fatty portions. We cannot take carbon, sulphur, phosphorus, lime, chlorine, iron, potash, soda, in their simple forms; but they are contained in the plants and in the flesh that form our common diet, or in the

water we drink, or, as in the case of salt, supplied as condiments. The body is a soil capable of being improved by adding the elements in which it is deficient as much as farming or garden land. The cook makes our bodies, the apothecary only cobbles them.

Alcohol and Narcotics.—All alcoholic drinks have certain effects in common; that is, all affect the brain more or less. A single glass of lager beer changes the current of thought and the tone of feeling in a person not in the habit of using stimulants. But alcoholic drinks differ entirely from each other in some of their effects. Champagne, beer, gin, brandy are all well known to produce influences on particular functions, in addition to their action on the brain, which again is by no means identical in all these liquors. The experience of those who train for athletic sports has abundantly shown that alcoholic drinks and narcotics form no part of a regimen meant to insure the best physical condition.

Coffee, in excess, produces heat, headache, tremors, wakefulness, and a kind of half insane disconnection in the association of ideas.

Tea, in excess, is liable to cause wakefulness and palpitations. The heart tumbles about in a very alarming way sometimes, under its influence.

Tobacco.—A danger to which smokers are exposed is injury to the temper, through the increased irritability which the practice is apt to produce, and to the will which it is powerful to subjugate. This habit introduces into the conduct of life one of the most imperious forms of self-indulgence known to experience. Our state prison convicts are said to pine for

their tobacco more than any other luxury of freedom. The amount of duty unperformed, or postponed, or slighted, in obedience to the craving for the narcotic stimulant, must form a large item in the list of the many things left undone which ought to have been done. Carry the use of the strange herb a little further, and the partial palsy of the will extends to other functions. The sense of vision is one of the first points where the further encroachment of the drug shows itself. Many cases of loss of power in the nerve of the eye are traced to the free use of tobacco. Some hard smokers are great workers as we all know, but few who have watched the effects of nicotization on will and character would deny that it handicaps a man, and often pretty heavily, in the race for distinction.

Clothing.—We may learn a lesson in the matter of clothing from the trainers and jockeys. They blanket their horses carefully after exercise. We come in heated and throw off our outside clothing. Why should not a man be cared for as well as Flora Temple or Dexter?

Exercise.—It is by no means so easy to lay down precise rules about exercise, as many at first thought suppose. When one is told to walk two or four hours daily, it seems as if the measure of time was the measure of work to be done. But one person weighs a hundred pounds and a little over, a large part of it muscle, which does not feel its own weight; and another person weighs two hundred and fifty pounds, three-quarters of it inert matter, nearly as hard to carry as if it were packed in boxes and bundles.

Two points deserve special attention connected with exercise—the æration of the blood and its distribution. Exercise

drives it more rapidly through the lungs and quickens the breathing in proportion. You will see persons, not in love, so far as known, who sigh heavily from time to time. It is simply to make up arrears of their languid respiration, which leaves the blood over-carbonated and under-oxygenated. A deep breath sets it right for the moment, as the payment of a long bill disposes of many petty charges that have been accumulating.

During exercise the muscles want blood, and suck it up like so many sponges. But when the brain is working, that wants blood, and when the stomach is digesting, that wants blood, and so of other organs.

The effects of prolonged *training* on the after-conditions of the subject have often been questioned. The recent death of Chambers, the rowing champion of England, of consumption, has called attention anew to the matter. Dr. Hope has pointed out the danger of bringing on disease of the heart by over-exertions in boat races and Alpine excursions. When a young man strains himself in a rowing match until he grows black in the face, he is putting his circulating and breathing organs to the hazard of injuries that are liable to outlast the memory of all his brief triumphs. "It is the pace that kills," is an axiom as applicable to men as to horses.—*From essay on "Care and Management of the Human Body."*

Our brains are seventy-year clocks. The Angel of Life winds them up once for all, then closes the case and gives the key into the hand of the Angel of the Resurrection.

Tic-tac! tic-tac! go the wheels of thought; our will cannot stop them; they cannot stop themselves; sleep cannot still

them; madness only makes them go faster; death alone can break into the case, and seizing the ever-swinging pendulum which we call the heart, silence at last the clicking of the terrible escapement we have carried so long beneath our wrinkled foreheads. If we could only get at them, as we lie on our pillows, and count the dead beats of thought after thought and image after image jarring through the overtired organ!

Unless the will maintain a certain control over these movements which it cannot stop, but can to some extent regulate, men are very apt to try to get at the machine by some indirect system of leverage or other. They clap on the brakes by means of opium; they change the maddening monotony of the rhythm by means of fermented liquors. It is because the brain is locked up and we cannot touch its movement directly that we thrust these coarse tools in through any crevice, by which they may reach the interior, and so alter its rate of going for a while, and at last spoil the machine.

* * * * * * *

I think you will find it true that, before any vice can fasten on a man, body, mind or moral nature must be debilitated. The mosses and fungi gather on sickly trees, not thriving ones; and the odious parasites which fasten on the human frame choose that which is already enfeebled. Mr. Walker, the hygeian humorist, declared that he had such a healthy skin it was impossible for any impurity to stick to it, and maintained that it was an absurdity to wash a face which was of necessity always clean. I don't know how much fancy there was in this; but there is no fancy in saying that the

lassitude of tired-out operatives, and the languor of imaginative natures in their periods of collapse, and the vacuity of minds untrained to labor and discipline, fit the soul and body for the germination of the seeds of intemperance.

Whenever the wandering demon of drunkenness finds a ship adrift—no steady wind in its sails, no thoughtful pilot directing its course—he steps on board, takes the helm, and steers straight for the maelstrom.

* * * * * * *

I do not advise you, young man, to consecrate the flower of your life to painting the bowl of a pipe, for, let me assure you, the stain of a reverie-breeding narcotic may strike deeper than you think for. I have seen the green leaf of early promise grow brown before its time under such nicotian regimen, and thought the umbered meerschaum was dearly bought at the cost of a brain enfeebled and a will enslaved.

* * * * * * *

The pleasure of exercise is due first to a purely physical impression, and secondly to a sense of power in action. The first source of pleasure varies, of course, with our condition and the state of the surrounding circumstances; the second with the amount and kind of power, and the extent and kind of action. In all forms of active exercise there are three powers simultaneously in action—the will, the muscles, and the intellect. Each of these predominates in different kinds of exercise. In walking the will and muscles are so accustomed to work together and perform their task with so little expenditure of force, that the intellect is left comparatively free. The mental pleasure in walking, as such, is in the sense of power

over all our moving machinery. But in riding I have the additional pleasure of governing another's will, and my muscles extend to the tips of the animal's ears and to his four hoofs, instead of stopping at my hands and feet. Now in this extension of my volition and my physical frame into another animal, my tyrannical instincts and my desire for heroic strength are at once gratified. When the horse ceases to have a will of his own, and his muscles require no special attention on your part, then you may live on horseback as Wesley did, and write sermons or take naps, as you like. But you will observe that in riding on horseback you always have a feeling that, after all, it is not you that do the work, but the animal, and this prevents the satisfaction from being complete.

But if your blood wants rousing, turn round that stake in the river which you see a mile from here, and when you come in in sixteen minutes (if you do, for we are old boys and not champion scullers you remember), then say if you begin to feel a little warmed up or not! You can row easily and gently all day, and you can row yourself blind and black in the face in ten minutes, just as you like. It has been long agreed that there is no way in which a man can accomplish so much labor with his muscles as in rowing.

We have a few good boatmen—no good horsemen that I hear of—I cannot speak for cricketing, but as for any great athletic feat performed by a gentleman in these latitudes, society would drop a man who should run around the Common in five minutes. Some of our amateur fencers, single-stick players, and boxers, we have no reason to be ashamed of. Boxing is rough play, but not too rough for a hearty, young

fellow. Anything is better than this white-blooded degeneration to which we all tend.—*From "The Autocrat of the Breakfast Table."*

There are three wicks, you know, to the lamp of a man's life: brain, blood, and breath. Press the brain a little, its light goes out, followed by both the others. Stop the heart a minute, and out go all three of the wicks. Choke the air out of the lungs, and presently the fluid ceases to supply the other centers of flame, and all is soon stagnation, cold, and darkness. The "tripod" of life a French physiologist called these three organs.—*From "The Professor at the Breakfast Table."*

THE LIVING TEMPLE.

The smooth, soft air, with pulse-like waves,
Flows murmuring through its hidden caves,
Whose streams of brightening purple rush,
Fired with a new and livelier blush,
While all their burden of decay
The ebbing current steals away,
And red with Nature's flame they start
From the warm fountains of the heart.

No rest that throbbing slave may ask,
Forever quivering o'er his task,
While far and wide a crimson jet
Leaps forth to fill the woven net
Which in unnumbered crossing tides
The flood of burning life divides,
Then, kindling each decaying part,
Creeps back to find the throbbing heart.

But warmed with that unchanging flame
Behold the outward moving frame,
Its living marbles jointed strong
With glistening band and silvery thong,
And linked to reason's guiding reins
By myriad rings in trembling chains,
Each graven with the threaded zone
Which claims it as the master's own.

See how yon beam of seeming white
Is braided out of seven-hued light,
Yet in those lucid globes no ray
By any chance shall break astray.
Hark how the rolling surge of sound
Arches and spirals circling round,
Wakes the hushed spirit through thine ear
With music it is heaven to hear.

Then mark the cloven sphere that holds
All thought in its mysterious folds,
That feels sensation's faintest thrill,
And flashes forth the sovereign will;
Think on the stormy world that dwells
Locked in its dim and clustering cells!
The lightning gleam of power it sheds
Along its hollow, glassy threads!

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